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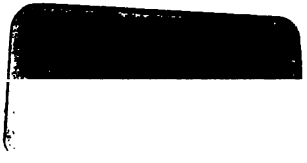
BURCHETT'S

PRACTICAL PERSPECTIVE



PRACTICAL PERSPECTIVE.

Department of Science and Art.

PRACTICAL PERSPECTIVE.

THE COURSE OF LECTURES

ON

LINEAR PERSPECTIVE,

DELIVERED AT, AND FORMING A PART OF,

THE INSTRUCTION IN THE TRAINING SCHOOL, MARLBOROUGH HOUSE, AND IN THE SCHOOLS OF ART IN CONNECTION WITH THE DEPARTMENT OF SCIENCE AND ART.

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INTRODUCTION.

NOTWITHSTANDING the number of books in circulation on the science of Perspective, it is repeatedly asserted that it cannot be learnt from books; and although this cannot necessarily be true, it is greatly to be feared that too many students find it true in their own individual cases; perhaps this arises from two causes—first, the science of Perspective, although in its fundamental principles *extremely simple*, demands from those employing it an application differing frequently with every subject, and presenting new features each time it is employed—an ability of application which can only result from a *thorough* understanding of those fundamental principles. Secondly, the books published on Perspective may be broadly divided into two classes, the profound and abstruse, and the simple and unprincipled. The first treat the subject as an elaborate science, demanding for their comprehension a great amount of previously obtained knowledge, not often to be found amongst those most requiring a knowledge of Perspective, and offering rather a large number of abstract laws, than of practical applications of them.

The second class, appear to treat Perspective rather as an art, than as a science; and in their great anxiety to avoid embarrassing their readers with science, forget to furnish him with PRINCIPLES; supplying him instead with a number of RULES—many of which are needless repetitions of the results of the same principle or law; and yet these, numerous as they are, leave a great number of cases unprovided for—upon one of which the student stumbling, finds his fancied knowledge of Perspective an ignis fatuus that has tempted him to a quagmire and then betrayed him.

It has been my earnest endeavour to prevent the following pages from belonging to either of the above categories; they are the substance of a course of lectures on Perspective, delivered to the masters in training at the Central Training School of the department of science and art; a course which has been repeated about eight times, not without fresh thought, and an endeavour to improve on each renewed occasion; it is hoped not without success, in the attainment of the object sought, the securing to the pupils the *understanding* of the subject taught, in order that they might be competent to instruct others.

The work will assume, therefore, somewhat of a *condensed oral character,* from believing that this is much more likely to secure the desired result, than a method which merely directs the hand without informing the understanding. The illustrations will be as full as the nature of the work will permit, and if in some cases there may appear to be redundant repetition, it is hoped that such may be excused on the plea that it is better to be told twice than to forget.

As the present course is in class preceded by a course

of Practical Geometry, and as that course of Practical Geometry has also been the published precursor of the present work, all the necessary knowledge, very limited, of Practical Geometry, whether of terms or figures, is supposed to be possessed by the student before he enters upon the study of Perspective, this possession being essential.

With this previous knowledge of Practical Geometry the student may enter, without fear of being confounded, upon the following course: he must, however, be warned that, he must not begin at the end or in the middle, that he must not expect to understand fig. 15 before he has mastered fig. 5, but that he must be satisfied to acquire his knowledge in the order of the pages; that he must not be content with reading, but must assure himself that he understands both text and figures; and his attention is particularly requested to what may appear the preliminary matter, and to the illustrations accompanying it.

The student is earnestly advised to master thoroughly each step as he proceeds; if he does so, it is believed that he will find no difficulty in any of the figures: should he not do so, and the figures appear too complex and elaborate, or should he find to his discomfiture, preliminary steps omitted in the advanced figures, which it is taken for granted he has already acquired the knowledge of, he must have the fairness to acknowledge that it is not the teacher's fault, but his own, and that the only sound policy will be to retreat to the point where he is thoroughly strong, and start afresh.

It is also most desirable that, *as the student proceeds,* he should practise upon other similar objects the methods employed in the course, as oftentimes the application of the

knowledge he has acquired in the lesson to a different object will do much more than mere copying, towards giving him a full knowledge of the subject, as it *compels him to think.*

It has been thought desirable to divide the work into lessons, each of which may be supposed to correspond with the original division into lectures; this method rendering reference more easy, as well as furnishing matter which might be thought sufficient for a lesson should the work be found useful to teachers.

It is proper to premise that the Perspective here taught is such as artists practise and believe in; such as all who attempt to *draw* should know: that it does not meddle with curvilinear horizontal lines, does not assert that vertical lines converge, nor propose as exercises the painting of imitation cupolas upon flat ceilings, which require the spectator to lie upon his back on the floor to the detriment of clothes and the derangement of his head, in order to the realisation of the truth of the work. But on the contrary, it professes to believe that lines that are straight in fact should be straight in their representation; that the men forming a well dressed line of infantry would, if viewed under the conditions specified, *appear* to stand upright and not all converging in the direction of the central man, bearing in mind that the *appearances* of the *representations* of objects are subject to the same optical laws as the appearances of the objects themselves, and the exercises it proposes are such as may consistently be placed upon a vertical wall and examined at least without *physical* discomfort.

It may not be out of place here to say a few words on

the general value of a knowledge of Perspective, it being too often considered necessary only to architectural draughtsmen, or to those artists who employ architecture in their pictures, and too often not possessed even by those.

This, however, is a very grave mistake—the laws of Optics are those which regulate the *appearances* of objects, the laws of Perspective are the corollaries of those laws, and they govern the *representation* of the appearances of objects; all drawing is a representation of appearances, and how halting and imperfect must the work be when it is executed in ignorance of the very laws which should govern its production.

The moment when a student ceases to draw from a flat copy and enters upon the study of solid forms, he commences the labour of translating *facts* into *appearances*; the laws of Perspective govern this translation. At this stage how often is it found that the known facts of the object are at conflict in the student's mind with his conception of the appearances, resulting in a representation at discord both with appearance and fact: a knowledge of Perspective would have removed this erroneous impression, would have reconciled this discrepancy; and one great value of Perspective most undoubtedly is the power it imparts of *seeing correctly*. The laws of Perspective abiding in the mind and guiding the hand in every line it may draw, even when an actual application of its rules would be as impossible as unproductive.

Should any one believe that an exaggerated value is here placed upon the knowledge of Perspective, I would refer them to Professor Leslie's recent valuable contribution to Art-literature, "Hints to Young Painters," where its

importance to Art is dwelt upon in language as forcible as true; and from the book I would refer them to his picture in the Vernon Gallery, "Sancho Panza relating his Adventures to the Duchess," where the precepts are reduced to practice: and if the book and the picture together do not convince, I should despair of the result of any further reasoning on my part.

MARLBOROUGH HOUSE,

March, 1856.

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LINEAR PERSPECTIVE.

LESSON I.

ALL objects are *seen* in accordance with the laws of *Optics* or Vision. Objects may be *represented as they are*, in accordance with the laws of *Geometry; as they appear*, by the laws of *Perspective*.

Perspective is divisible into Linear and Aerial. Linear Perspective, that is, the perspective of lines, concerns itself with the alterations which the *forms* and *sizes* of objects appear to undergo. Aerial Perspective, the Perspective of Air, with the *relative distinctness* of the forms and colours of objects, such modifications in both cases being dependent upon the relative nearness to, or distance from, the spectator.

The present work treats of Linear Perspective alone.

The term Perspective, *signifying to see through*, is applied to those delineations of objects which represent them as they appear to the eye, when seen in different positions and distances—such *appearances* being generally different from the real *facts* of the objects—as forms equal in size appear greater or less than each other, more or less distinct, as they relatively approach to, or recede from, the eye.

If, having shut one eye, we keep the other steadily fixed, *looking through* a square of glass, at any objects beyond it, we shall obtain a *perspective view* of those objects; if we cover the square of glass with tracing paper, and with a pencil draw the *outlines* of the objects as they appear through it, we shall have made a linear *perspective drawing*, the tracing paper becoming

a *Plane of Delineation*—and if we have chosen to look down a street, a row of columns or of chimneys, &c., we shall have convincing proof that objects, equal in size, appear to diminish as they increase in distance from the spectator, and the surface on which the drawing was made.

Geometry makes us acquainted with the *real facts* of objects, giving us the component parts individually and separately ; it walks, as it were, round an object and analyses it in detail ; it gives us the front and back of a box, its ends, its top, and its bottom, with the precise and real dimensions of each ; but in order to do this, it must give one view of the end, one of the front, another of the top, as *a*, *b*, *c*, fig. 1, plate 1.

Perspective, on the contrary, enables us to represent the *appearance* of the whole box at one view, as fig. 2.

Geometry, then, may be said to be the science of *realities*—Perspective, that of *appearances*—but the appearances of objects depend upon their facts. Perspective is dependent upon Geometry for its facts, and through Optics, also, for the laws or rules which enable us to imitate the appearances of objects.

Let us here briefly notice some of the phenomena of vision or optics. Man usually possesses *two eyes*, and generally uses *both at once*, *each eye* being capable of perfect vision ; in perfect eyes the vision is supposed to be in ordinary circumstances, *direct*, that is, looking straight out ; the axes of the two eyes being parallel to each other, as at fig. 3, where *a*, *a*, represents the two eyes, *b*, *b*, the two axes. If the two axes are *divergent*, as in fig. 4, a character of what may be called vacuity, *a not looking at anything particular*, results ; and if, on the other hand, the axes are made to *converge* as in fig. 5, this may be tested by bringing any small object near to the eyes and looking at it with them both, the result is squinting. If the normal condition of any eyes resemble fig. 4, or 5, it is an imperfection of the organs of vision.*

* The eye undoubtedly adapts itself to circumstances, whether of limited or extended vision, but the parallelism of the eye may be considered its normal state.

But if we have two eyes, each capable of perfect vision, both employed at one time, the axes of both remaining parallel, it will follow that we shall obtain *two slightly different views* of any object or objects coming within the range of our vision, and this is always the case; from those *two slightly different* views, however, the mind realises *one distinct image.*

If a quarto volume, say not more than one inch in thickness, be placed with its back towards the spectator directly in front of his eyes, and two or three feet from him, he will be able to see the faces of both of its covers, as in fig. 6, where *a*, *a* represents the two eyes, *b* the back, and *c*, *d* the *two* covers of the book; the lines *c*, *a* and *d*, *a*, representing rays which pass from, and therefore render visible, the *two covers* of the book, the back and *one cover* being visible to *each eye.* But if we shut one eye, then the back and one cover only is visible, and we find that we have a more decided image; thus in shooting, one eye is generally closed while a direct ray passing along the centre of the barrel is produced to cut the object aimed at; thus in fig. 7, let *a*, *b*, represent the two eyes, *c* the object aimed at, and *d* the barrel. Eye *a* being closed, the whole of the barrel *d* is brought to coincide with the ray passing from *c* to *b*; but if eye *a* be opened, the ray passing from it to *c* will not coincide with any portion of the barrel, and if the end of the barrel be brought to coincide with a portion of the ray from *a*, as at *e*, then the contents of the barrel would proceed in the direction of *f*, in which case they would not be likely to do much injury to *c*. This use of one eye alone is also occasionally of great value in the earlier stages of art education, as the appearance of *relief* becomes by that means more vivid, and impresses itself more decidedly upon the mind of the student.

To return to fig. 6. This production of one mental image from two slightly different appearances is performed without effort on our part, and with sufficient success when those appearances result from *real objects*; the organ of *mental Vision* which is one, not the *physical* organs, which are *two*, being supposed

to reside in a point central to the two eyes. The Stereoscope beautifully performs this operation where the mental vision is obtained from *representations ;* but it does so by providing two *slightly different* representations, and limiting *each eye* to seeing only one of those, although both representations must be seen by the two eyes at the same moment; those two different representations presenting a distinctly different appearance of the object to each of the two eyes. The mental image being formed therefore from two properly different but *unconflicting* representations, the result as might be expected is more real than reality itself.

Perspective being then required to represent the appearances of objects, or to *reproduce the results of mental vision,* IT REGARDS THE ORGAN OF VISION AS ONE.

When the eyes are open to the light, light streams into them from space, the *light constituting what may be termed a flood of rays ;* if any object or objects occupy a portion of that space, the rays passing from every part of those objects will convey to the eye the image of the part from which they pass; and we thus become cognisant of the existence of objects in space. Where the medium through which those rays pass exercises no deranging influence, the rays pass in *straight lines,* and even where deflection occurs it does not affect this principle in so far as Perspective is concerned; thus water deflects, or bends, rays passing through it. As fig. 8. Let *a* represent an eye, *b* the surface of some smooth water, *c* the bottom, and *d* a stone lying on it. The ray of light from *d* to *a* represented by the straight line *a d,* will be deflected or bent at the surface by passing through the medium of water as the line *e f,* from *e* the ray will pass to the eye as *e a.* But from this deflection of the ray the stone *d* will *appear to lie* at *f.* On the other hand let *g, h* represent a stick in the water, by the deflection of the ray it will appear to be bent in the direction *i,* the ray appearing to pass from *a* to *i* in a straight line, but being really bent as *i, k, a.* But Perspective represents the *appearances* of objects, therefore it would represent

the stone as appearing to lie at *f*, and the stick to be bent as *g*, *k*, *i*.

Therefore for Perspective, we may truthfully assert that, ALL RAYS PASS IN DIRECT STRAIGHT LINES FROM OBJECTS TO THE EYE.

We have endeavoured to show by what means one mental image is obtained by the use of two eyes, and to explain by the Stereoscope the necessity of a difference in the two appearances which are to produce one image. Let us now suppose that instead of both eyes being directed to one object, each eye should look upon a different one, if this were possible, not each eye seeing *two objects*, but each eye seeing a *different one;* the result would be a mental image compounded of the two objects: thus, if in a Stereoscope we place a slide, having on it in the proper places a drawing, of a square, and of a circle having the same diameter as the square, as *a*, fig. 9, we shall find the two forms produce an appearance similar to *b*, fig. 9; this, therefore will prove that, although a difference exists in the views which go to form the one mental image, that such difference is *limited.* But *two portions of one object* may differ as widely as two different objects, therefore if one mental image be derived from the separate appearances of two such portions, it will be one partaking of the form of both those appearances; thus, if in *e*, fig. 10, one eye could be made to regard portion *a* alone, and the other eye to see only portion *c*, the mental image resulting would be *d;* which would certainly not be a correct one of the whole form; it is necessary, therefore, that *both eyes should be able to see*, and if both are used *that they should see, at once, all the objects or all parts of an object of which a mental image has to be formed.* But if one eye may thus not move away from its fellow to contemplate another portion of the same object without a derangement of the mental image, it will evidently follow that the derangement will be still greater if both eyes are moved from object to object, or from part to part, as by so doing we should obtain a succession of mental images which might produce a *general idea* of the whole *dwelling in the*

memory, but which could not produce one *distinct mental image of the whole as seen at once.*

But Perspective presents a representation of a distinct mental image of the whole as seen at once. Therefore it regards, and for its purposes requires, the *one seat of vision* TO BE ABSOLUTELY FIXED AND IMMOVABLE FOR THE TIME BEING.

It is necessary that the seat of vision should remain fixed, in order that the rays may pass from the same portions of objects to the eye. But if while the eye remains fixed, the objects on which it looks be allowed to move, this movement would cause fresh portions of the object to transmit rays to the eye, rendering visible probably portions of the object which at first were invisible, and thus producing a derangement of the mental image.

Therefore Perspective demands that THE OBJECT OR OBJECTS SHOULD, FOR THE TIME BEING, BE STATIONARY.

We may then assert, that in Perspective,

1. ONE SEAT OF VISION IS EMPLOYED, or, in other words, only one eye supposed to be used.

2. THE ONE SEAT OF VISION MUST BE REGARDED AS ABSOLUTELY FIXED AND IMMOVABLE FOR THE TIME BEING.

3. THE OBJECTS TO BE REPRESENTED MUST BE TREATED AS STATIONARY, and,

4. THAT THE RAYS OF LIGHT PASS IN STRAIGHT LINES FROM THOSE OBJECTS TO THE EYE.

Rays of light pass in straight lines from all visible objects however large, to the small transparent surface of the eye. Let *a*, Fig. 11, represent an eye, *b* an object. Rays *c* and *d* pass in *parallel* straight lines from the object to the eye, but by their means only a portion of the object, equal in size to the eye itself, is visible,—If, therefore, the rays of light are *parallel* as well as straight, we should require to move the eye in order to see any object larger than itself; BUT THE EYE, BEING A SPHERICAL, OR CONVEX SURFACE, COLLECTS ALL THE RAYS WITHIN CERTAIN LIMITS, WHICH ARE THUS MADE TO CONVERGE IN ITSELF.

By means of this convergence we can see objects of the greatest magnitude by removing to a sufficient distance from them, as in fig. 12. But as the *distance from the object is increased*, or, in other words, the *rays lengthened*, they become weaker, or transmit the image with less distinctness. When we wish to see a whole building at one view, we withdraw to a considerable distance from it, in order that rays may pass from every portion of it into the eye at one time; but, when we wish to examine its details, we approach close to the portion we wish to inspect, diminish the extent of our field of vision, and the shortened ray transmits distinctly every detail of the object examined.

But, if when the eye is fixed, it be necessary to increase our distance from an object in proportion to its bulk, in order to see the whole of it at once, without any movement of the eye, as in fig. 12, it is evident; although, in consequence of the rays of light converging, we are able to see much more at once than we could if the rays were parallel, that there is some limit to the angle of convergence.

The rays pass from external objects through the opening in the iris called the pupil of the eye, A, fig. 13, plate 2, they converge in the crystalline humour, or lens, B, and are transmitted on to the retina, C, on which the object seen is represented; from this representation the mental image is formed. The angle of convergence, or, in other words, the angle of vision, will depend then upon the size of the opening in the iris through which the rays pass, that is, the pupil; and the distance, from this opening, of the point of convergence in the crystalline lens; but both the pupil and the crystalline lens are capable of adjustment; the pupil may be contracted or dilated, and the lens may approach, or recede from, the surface of the eye in a minute degree. It is found, however, by experiment, that an angle of sixty degrees is generally the greatest that can be employed as an angle of vision in order to see at all distinctly the whole field lying within the angle; that is, the two outside rays, D and E,

fig. 13, must not make with each other a greater angle than sixty degrees. This is a limit assumed for practical purposes, *absolute distinctness* of vision resides alone in the *central ray*, F. We are all conscious that in closely examining even a small object, we direct our eye in rapid succession to every portion of it, passing, in fact, the central ray over the whole object.

As an experiment, place the back of a quarto volume, as fig. 14, three feet from the eye, and on a level with it, fix the eye steadily on the band *a, look directly on this object for a few seconds*, and, although the eye will be sensible of the presence of lettering in the spaces 1 and 2, we shall have but a confused idea of the title of the book; and if, instead, we direct the eye steadily to space 1, for the purpose of perusing the title, we shall require to direct the eye from space 1 to 2 before we can obtain a knowledge of the inscription within it, and this motion of the eye will be *quite sensible* to any one making the experiment with care.

It is sometimes advised that a less angle of vision should be employed, some limiting it to fifty, some forty-five, and some forty degrees; but the angle of sixty degrees has many advantages as enabling more of an object to be seen, and as it produces no distortion in the perspective drawing, it has very great recommendations.

We may assert then, as further deductions in addition to the four first,

5. THAT THE RAYS OF LIGHT CONVERGE IN STRAIGHT LINES TO A POINT WITHIN THE EYE. And,

6. THAT THE ANGLE OF CONVERGENCE OF THE EXTERNAL RAYS SHOULD NOT EXCEED SIXTY DEGREES.

But the transparent surface of the eye, the pupil, through which the rays pass, is a circle—through every portion of this surface rays are passing in straight lines converging to the central point within it; it follows therefore that, those rays in their convergence will form *a cone of rays*: and if sixty degrees is the limit of the angle of vision, the cone of rays will be a *cone of sixty degrees*. If we imagine this cone to be cut from

its apex downwards, through its centre, its section will contain the angle of an equilateral triangle. Let fig. 15 represent the section of the cone of rays, *a*, *b* and *a*, *c* being its limiting rays. Within this cone, or any production of it, as at 1, 2, or 3, objects will be visible until the rays are produced to such a distance as to be beyond the power of vision, but nothing will be visible outside its two bounding lines or rays. The whole of line 1 being visible at 1 and also at 2 or 3; the whole of line 2 being visible at 2 or 3, but only a portion of it, line 2, would be visible at 1, and so of line 3.

If the student obtain a colander and pass a number of *straight wires* through the apertures in its circular bottom, *drawing them up to a point on the inside*, he will be able to illustrate, very simply and clearly, the point of convergence by the extremities of the wires brought together on the inside; the surface of the eye, by the outer surface of the bottom of the colander, and the cone of rays by the straight wires passing through it.

The magic-lantern also supplies a good illustration, the light within being, in this case, the seat of the rays, the circular lens representing the surface of the eye. The light streams through in lines or rays forming a *cone of light*, and if this light falls upon a surface perpendicular to its central ray, it will form a *circle of light*, which circle will be the base of the cone of rays.

We thus obtain, then, another deduction, the

7. THAT THE RAYS PASSING INTO THE EYE MUST NECESSARILY, AND ALWAYS DO, FORM A CONE OF RAYS.

Before proceeding further let the student fully understand these seven deductions, and realise them thoroughly to his own mind and memory.

LESSON II.

It is most important to bear in mind that the rays of light passing into the eye always form a cone, whether those rays pass from any object, or from space, or in other words, whether the rays passing from an *object* or *objects*, convey an *image* or *images* to the retina; or proceeding from *space* they convey merely *light*, this cone being dependent wholly upon the circular form of the pupil of the eye, and not at all upon the forms or objects seen.

It has been asserted that rays pass from every portion of the surfaces of objects exposed to the eye, in doing so they convey the image or representation of the point from which they proceed to the retina. When in the first illustration it was proposed to look fixedly through a square of glass at objects beyond, the rays passing to the eye, would convey *through* the glass, the image of each portion of the surface from which they came into the retina; when the tracing paper was placed upon the glass, the rays, and the images conveyed by them, were intercepted by the square of glass covered with tracing paper; and a representation of the image was delineated upon it. The *square* of glass becoming the *Plane of Delineation*, and forming a part of a *circular* base of the cone of rays.

Let us suppose I, A, B, Fig. 16, plate 2, to be the vertical section of a cone of rays passing from A, B, a plane seen edgewise, having certain divisions 1, 2, 3, 4, 5, marked upon it. Let the circle C represent the plan of the base of the cone of rays, and its centre I the point of convergence, I will be one ex-

tremity of the central ray, in a word, the station of the eye—the central ray seen *end*wise—the central line of the cone, I 3, will be the same central ray, or as it is commonly called, the *principal visual ray* seen *lengthwise*—the equilateral triangle A, I, B, representing the profile, and the circle C the front view of the cone of rays—the centre I, of the circle, corresponding with I, the vertex of the triangle, and the diameter C D, of the circle, with the base A B of the triangle.

Now let us interpose a plane at E, perpendicular to the principal visual ray I 3, which is represented also by the smaller circle, the line E, being the diameter of the smaller circle E, as the line A B, is the diameter of the circle C, D—in fact, the line E, may represent the edge, and the circle E the flat surface of the pane of glass; but the rays drawn from 1, 2, 3, 4, 5, on the line A B, subdivide also the line E,—and if, having drawn similar divisions on the circle C, D, we draw lines from their extremities to the centre I, we shall have obtained lines on the smaller *circle* E correspondent to the divisions on the *line* E.

But the line A B, may represent the face of a rectangular plane, as F, G, H, K. Then all that portion of the plane F, G, H, K, which lies without the circle, that is without the cone of rays, could not be seen from I—in order to see the whole we must remove further from it. But those portions which lie without the cone of rays, would also of course be invisible, and therefore could not be represented at the line or within the circle E. The circle E representing a *transparent* base or plane within the cone of rays, only so much of the plane F, G, H, K, would be visible as is contained in the transparent *circular* base or plane C. But if the plane F, G, H, K, be reduced to L, M, N, O, then the whole plane is visible, and may be delineated upon the *transparent base or plane* E, as at *l*, *m*, *n*, *o*, and although the segments *l m*, *m n*, *l o*, and *n o*, are not employed in the representation of Plane L, M, N, O, nevertheless it is evident that a circular transparent base or plane of lesser diameter, could not be used if we wish to see

the whole of the plane L, M, N, O, as *its extremities touch the circumference of the base of the cone.*

If we suppose the plane *l, m, n, o,* to represent a square of glass, in other words, a *transparent vertical plane,* we shall find that such plane is *a portion of the circular base of the cone of rays,* that the centre of such circle is immediately opposite the point of sight, or station of the eye, and that therefore this centre I, is *the centre of vision of the plane l, m, n, o.* Whatever relation the sides of the plane may bear to it, that is to say, if we choose to reduce the plane, making L, P, O, Q, its boundaries, still so long as any one of its angles touches the circle or the limit of the base of the cone of rays, so long must the circular base E remain the same, and the centre I will be the centre of vision—and also the circular base E remaining the same, the point I must remain at the same distance from it, as moving I nearer to E would of course cause the reduction of the diameter of E, if it be conceded that the angle at I shall not exceed the angle already drawn, 60 degrees.

To recur to the magic lantern as an illustration. When the slide containing the picture, is passed between the light, the seat of the rays, and the base of the cone of rays or disc, the rays passing through the picture, transmit the image to the disc; and we have on the base of this cone of rays the magnified representation of the picture through which the rays have passed.

If we reverse this process, that is, conceive of the rays passing *from* the image or object, as in the camera employed in photography, *through* the transparent surface or lens, their convergence in its focal point, the consequent transmission of the diminished representation of the object, to the side of the camera opposite to the lens, we shall have a correct idea of that operation which nature performs in our own visual organs, in accordance with the laws of optics, and the results of which are imitated by the application of the rules of perspective.

To the seven deductions obtained in Lesson I, we may add the following :—

8. THAT OBJECTS MAY BE REPRESENTED UPON A PLANE INTERPOSED BETWEEN THE ORIGINAL OBJECT AND THE EYE, SUCH PLANE BEING CALLED A TRANSPARENT VERTICAL PLANE, OR PLANE OF DELINEATION.

9. THAT SUCH PLANE OF DELINEATION MUST ALWAYS FORM A PORTION OF A CIRCUMSCRIBING CIRCLE OR BASE OF THE CONE.

10. THAT THE POSITION OF THE EYE, OR THE STATION POINT OF SIGHT, WILL NECESSARILY BE OPPOSITE THE CENTRE OF THE CIRCUMSCRIBING CIRCLE.

11. THAT THE DISTANCE OF THE EYE FROM THE PLANE OF DELINEATION SHOULD BE THE VERTICAL HEIGHT OF AN EQUILATERAL TRIANGLE, OF WHICH THE CIRCUMSCRIBING CIRCLE IS THE BASE.

In accordance with axiom 1, let I, fig. 17, represent the one eye employed, by axiom 2 to be regarded as a fixed point.

Let I 1, I*a*, I 2, I*b*, I*c*, and I*d*, represent rays passing in straight lines (ax. 3) converging (ax. 4) at an angle of 60° (ax. 5), and forming a cone of 60° (ax. 6).

Let *a b c d* represent the interposed plane, called the TRANSPARENT VERTICAL PLANE, or the PLANE OF DELINEATION (ax. 8), forming a part of the circumscribing circle, or base of the cone (ax. 9).

Let I, the POINT OF SIGHT, or the STATION POINT of the eye, be supposed to be opposite the centre C of the circumscribing circle or base of the cone (ax. 10), then I 1, 1, will be an equilateral triangle, and the distance of the eye, I C, from the plane of delineation, equal to the vertical height of such equilateral triangle (ax. 11). Line I C will represent the PRINCIPAL VISUAL RAY. The intersection of the PRINCIPAL VISUAL RAY with the *Plane of Delineation* may be called the CENTRE OF VISION.*

* The term Centre of Vision is employed instead of that more commonly used, the *Point of Sight*, to avoid that confusion which is apt to arise in the student's mind from using a term in one meaning and an equivalent term in another. Thus *Station Point* and *Point of Sight* both really express the position of the eye, yet the first only has been commonly used to indicate this position, while the last has been arbitrarily employed to indicate a point on the Plane of Delineation.

If the student has understood what has already been stated, he will have no difficulty in believing then, that, however the *plane of delineation a b c d* may be modified, as *a f g h*, so long as one of its angles, as *a*, touches the *circumference of the base of the cone of rays*, that circumference must remain the same; therefore, the cone being one of 60°, its *vertex, the station point of the eye*, must remain the *same in distance and position*, and therefore the *centre of vision* C, being opposite to the position of the eye, must also remain at C.

Let the circle, fig. 18, be the base of the cone of rays represented perspectively in fig. 17. Let C, fig. 18, the centre of the circle, represent C, fig. 17, the centre of vision. Let 1 C 1 be the *vertical diameter* of the base as at 1, 1, fig. 17. Draw a second diameter *perpendicular* to the first, as at 2, 2; if 1, 1, be a vertical *diameter*, then 2, 2, will be a *horizontal* diameter of the base of the cone of rays; this line may therefore be called THE HORIZONTAL LINE.

Let the equilateral triangle, 1 I 1, fig. 17, be represented in fig. 18 by the two equilateral triangles 1 D 1. The two triangles 1 D 1 being each equal to the triangle 1 I 1, the angular points D, D will represent the *distance of the eye* from the base of the cone; D, D, in fig. 18, will be representatives of I in fig. 17, they will be the POINTS OF DISTANCE. And as line 2, 2, is drawn through the centre of line 1, 1, and perpendicular to it, and as the points D, D, are obtained by the intersection of two equal arcs from the two extremities of 1, 1, therefore line 2, 2, if produced, will pass through points D, D, in other words, the *points of distance* will *necessarily* lie upon the *Horizontal Line* produced. Let *a b c d*, and *a f g h* in fig. 19, be two parallelograms representing the two, similarly lettered, in fig. 18.

We have, in fig. 17, an attempt to express the base of the cone of rays, the inscribed plane of delineation, and the position or station of the eye in relation to each other at one view. In fig. 18 we have a drawing in *elevation* of the same subjects, *except that* the points D, D, are the *representatives* of point I in fig. 17.

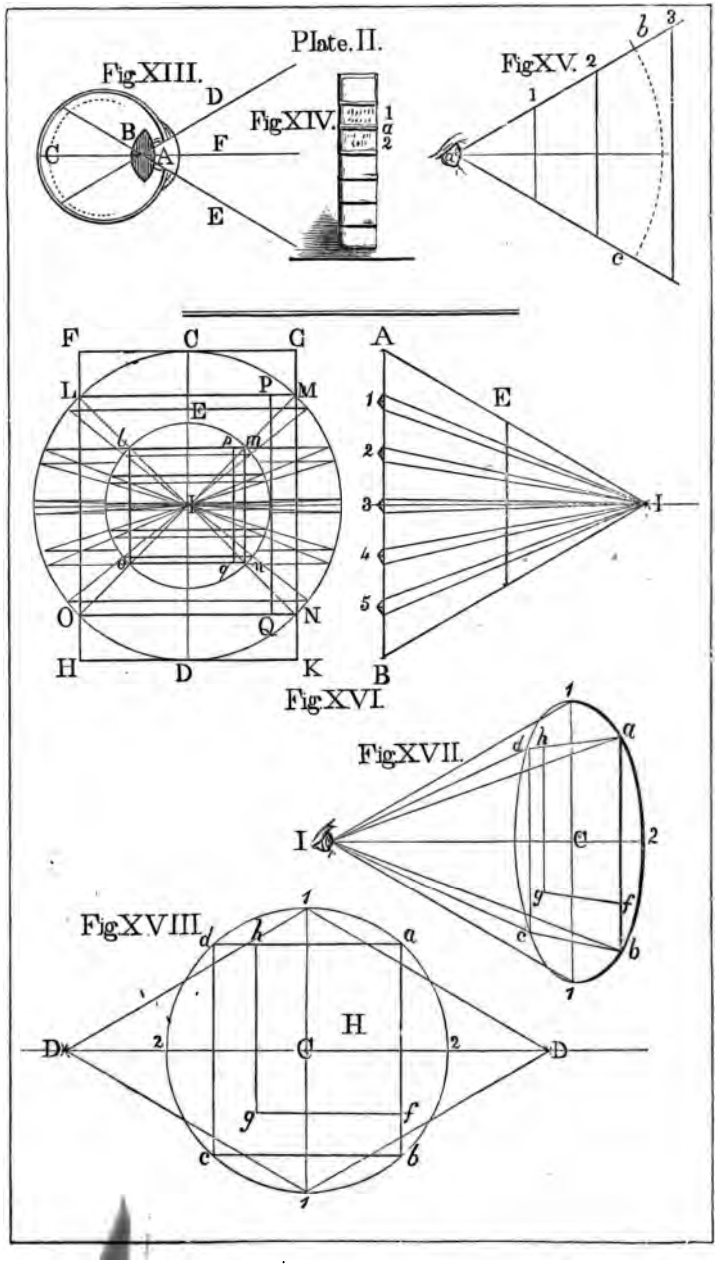


Plate. II.
Fig XIII.
D
B
C
A
F
E
Fig XIV.
1
a
2
Fig XV.
b
3
2
1
c
F
C
G
L
P
M
E
b
p
m
I
q
n
O
Q
N
H
D
K
A
E
1
2
3
4
5
I
B
Fig XVI.
Fig XVII.
1
d
h
a
I
e
2
g
f
c
b
1
Fig XVIII.
d
h
a
H
D
2
C
2
D
g
f
c
b
1

Fig. 19, plate 3, is a section of fig. 17, supposed to be cut through C perpendicular to line 1, 1, as at 2, 2, fig. 18. 2 I 2, fig. 19, is therefore a *section of the cone of rays*, C I the principal visual ray, 2 C 2 the base of the cone of rays—*a h* and *a d* the portions of the base occupied by the parallelograms *a b c d* and *a f g h*—objects will be *visible* then that are situated within the rays I 2, or any extension of those rays as at I 3. But the *plane of delineation*, being limited to *a h* or *a d*, such objects alone can be *represented upon those planes* as are situated within rays drawn from I through *a*, *h* and *d* as *i k l*, such rays being capable of being produced infinitely.

In fig. 18 the distance of the eye from the plane of delineation is represented by the points D, D, the distance of D from C being equal to the length of the line I C, fig. 17. I C being the *principal visual ray*, but I C in fig. 19 is equal to I C fig. 17, which is also equal to D C fig. 18, therefore the PRINCIPAL VISUAL RAY in fig. 17; the POINTS OF DISTANCE in fig. 18, and the STATION POINT I, in fig. 19, are, measuring from C, all equal to each other, and represent the same thing, the *distance of the spectator from the plane of delineation*, this distance, it has been endeavoured to show, cannot be lessened without diminishing the base of the cone of rays, which diminution would render some portion of the parallelograms *a b c d* or *a f g h* invisible, in other words, the points D, D, measuring from C, represent the nearest distance from which the whole of either of those parallelograms would be visible with the eye opposite to C. In the section fig. 19, the line I C is frequently called the LINE OF DIRECTION, meaning the direction of the principal or central ray. If, therefore, the length of the line C I be set off from C on the produced line 2 C 2, fig. 19, as at D, D, those points will represent the points of distance, the lines D, C, I, forming two sides of squares, of which lines D, I, will be the diagonals.

In Perspective drawings it is generally desirable to see as much of the objects represented as is consistent with the laws of vision; but the greater or less proportion of objects seen

will depend, within certain limits, wholly upon the nearness of the spectator to the plane of delineation; but it is evident that the spectator cannot approach nearer than a certain point without violating the laws of Optics; the truthful ascertainment of the nearest TRUE point of distance is therefore of the utmost importance, as upon this ONE TRUTH THE CORRECTNESS OF EVERY POINT TO BE EMPLOYED, AND OF EVERY LINE DRAWN, ABSOLUTELY DEPENDS.

Let us here recall the terms which we have endeavoured to *define*.

1. THE STATION POINT, the real position of the eye; it is represented at I, figs. 17 and 19.

2. THE PRINCIPAL VISUAL RAY, the *central* ray of the cone of rays; it is represented by I C, figs. 17 and 19. This is also sometimes called the LINE OF DIRECTION.

3. THE PLANE OF DELINEATION, the field or surface on which the drawing is to be made; this must always be a portion, or the whole, of the base of the cone of rays, but must never pass outside of that base. It is also sometimes called the TRANSPARENT VERTICAL PLANE; sometimes the PICTURE PLANE, or PLANE OF THE PICTURE; it is represented at *a b c d* and at *a f g h*, fig. 18.

4. THE CENTRE OF VISION, the point of intersection of the *Principal Visual Ray* with the *Plane of Delineation;* it is represented at C, figs. 17, 18 and 19.

5. THE HORIZONTAL LINE, passing through the centre of vision C; it is seen at H, fig. 18.

6. THE POINTS OF DISTANCE, the distance of the eye from the *Plane of Delineation* set off upon the *Horizontal Line;* they are represented at D, D, figs. 18 and 19.

Let us apply to practice the knowledge and terms we have already obtained, as far as it will go.

Let us suppose that a *Plane of Delineation*, or, in other words, a sheet of paper or canvass be given, on which it is required to make a drawing, as *a b c d*, fig. 20.

We are at liberty to assume any *centre of vision*, in other

words, we may determine that the eye shall be opposite to any portion of the plane *a b c d* we please; let us assume C.

We may at once draw the *Horizontal Line* H through C parallel to sides *a b* and *c d* of the given plane, and produce it.

Now it is necessary to ascertain the extent of the *base of the cone of rays*, of which *a b c d* will form a part:—from C, as centre, with a line drawn to the most distant angle as *b*, as radius, describe a circle; such circle will be a base of the cone of rays employed.

Draw a diameter of the circle perpendicular to the horizontal line, as 1, 1. From either extremity of 1, 1 with 1, 1, as radius, describe arcs cutting the horizontal line in D, D.

The points D, D, will be the points of distance. We have now obtained a result similar to fig. 18. Let us now incorporate fig. 19, as it were, with fig. 20.

Produce the vertical line 1, 1, making C, C, equal to C, D. Draw a line through the upper extremity of the produced line C, C, perpendicular to it. Produce the sides of the picture *d a* and *c b* to cut the line last drawn in 2, 2. Draw lines from the *centre of vision* C through 2, 2 and we obtain rays; any objects placed within which rays may be represented on the plane *a b c d* as X Y Z.

Observe, the *Plane of Delineation* was *given*, the *Centre of Vision* was *assumed* at the option of the spectator, but the *Horizontal Line* and the *distance* of the spectator from the Plane of Delineation is a *result.*

Note.—*The distance may be* ASSUMED *if it be* CERTAINLY GREATER *than the distance here obtained, but not without. The* RESULT *giving not the only distance at which it is possible to see the plane a b c d, but the* NEAREST.

Besides the six terms or definitions, which are already stated, we shall find it desirable to name two other lines already existing in fig. 20. In fig. 19 we have, at 2 I 2, a section of the cone of rays, the line 2, 2 representing the base of such cone seen edgewise, this line is called THE BASE LINE.

But in fig. 20 we have also a similar line B, a portion of which lying between the two rays 2, 2, represents the *Plane of Delineation seen edgewise.*

The limits of the Plane of delineation are of great occasional value in practice, and the *lower* edge, *c d*, may appropriately be called THE PICTURE LINE. From the fact that the picture is generally supposed to stand upon the ground, or that whatever plane the picture may stand on is generally regarded as the ground of the picture, this line is also called the GROUND LINE: either of these being preferable to using the term *Base Line* to indicate two lines distinct in their uses, as is frequently done by applying that term to both lines, line B and line *c d.*

We obtain then in addition to the six definitions already stated—

7. THE BASE LINE, a line drawn at the extremity of the *Principal Visual Ray*, and perpendicular to it; it is represented at B, fig. 20.

8. THE PICTURE LINE, the lower edge of the picture and parallel to the *Horizontal Line;* it is drawn at *c d*, fig. 20.

LESSON III.

—◆—

LET us now regard the plane *a*, *b*, *c*, *d*, fig. 21, plate 4, as a *Transparent Vertical Plane*, or *Plane of Delineation*, with the centre of vision C, and the horizontal line H upon it: the plane *a b c d* being a *transparent* portion of a larger opaque plane W X Y Z; *a b c d* may represent a pane of glass let into a black board; and now, supposing ourselves to be viewing any scene in nature, the eye being placed immediately opposite to the centre of vision C, let us notice the appearances.

If we have an unobstructed view of a level plain, or of the sea, we shall observe that such plain or sea will appear to rise as it recedes, until, at the extreme limit of vision, the plain or sea will appear to meet the sky, in a line immediately opposite to our eye, such line coinciding with the *Horizontal Line*. Let us imagine ourselves as first regarding the sea, *through the Transparent Plane*, from the shore; as we ascend a hill or cliff, always remembering that we carry the transparent plane with us, and keep the eye opposite to C, the line where sea and sky appear to meet, rises as we rise, and always appears on a level with us; so, in ascending a high hill in the midst of a plain, as we rise the view expands, and its limiting distance appears to rise also; in ascending in a balloon the landscape appears to rise in the form of a basin until the whole view is lost.

This apparent meeting of the level plain, or sea, with the sky is called the *Natural Horizon*, this natural horizon always appearing to be on a level with the eye of the spectator. But

the *Horizontal Line* being drawn through the *Centre of Vision* is necessarily opposite the eye of the spectator, therefore the *Natural Horizon will always coincide with the Horizontal Line.*

The level plain or sea may with propriety be called a horizontal plane; but if this horizontal plane *appears*, at the portion nearest us, to be on a level with our feet and at the most distant portion to be level with our eyes, we may with propriety assert that, this horizontal plane *appears to converge* in the horizontal line, and as this was the case from whatever height we viewed this plane, we may assert that all HORIZONTAL PLANES CONVERGE TOWARDS THE HORIZONTAL LINE. The plane of delineation is a *vertical* plane, any *horizontal* plane is therefore *perpendicular* to the plane of delineation or the picture; therefore all planes that are perpendicular to the plane of the picture, and at the same time are also horizontal planes, converge towards the *horizontal line.*

Let us endeavour to conceive of ourselves as looking at some large vertical, or upright, plane; let us suppose a wall, commencing close to the left side of our plane of delineation, and running onwards to a great distance, perpendicularly, or at right angles, with the plane of delineation. We shall observe in this case a precisely similar result to that in the last, that is, as the wall recedes from us, its surface will *appear to approach a line drawn vertically through the centre of vision;* or in other words, as horizontal planes converge towards the horizontal line, so all *vertical planes* that are at the same time perpendicular to the plane of the picture, will converge towards a CENTRAL VERTICAL LINE, that is, a line drawn vertically through the centre of vision.

Let us suppose our transparent plane to be placed at the end of a room, the size of the room corresponding to the dimensions of the transparent plane; then the floor and the ceiling will be two horizontal planes, and the two sides two vertical planes—See fig. 21, *a b* and *c d* being the lines of intersection of the ceiling and the floor with the picture plane,

and *a c* and *b d* those of the side walls. The horizontal planes of the floor and the ceiling are here *limited* by the two vertical planes, the side walls; the horizontal plane, the floor, being bounded by the *line* or edge of the vertical plane, the wall; this *line* is then a part of the vertical plane standing upon the horizontal plane, which plane converges towards the horizontal line: the *line* drawn upon the floor must of course accompany the floor, and it will therefore converge towards the horizontal line, but the vertical plane, of which it is a part, converges towards the central vertical line, and as the *line* drawn cannot violate the condition of the *plane on which it is drawn*, nor of the *plane to which it belongs*, it is evident it must converge in some point where the two planes of which it forms a part intersect, and as the horizontal line and the central vertical line intersect each other at the centre of vision; therefore the lines which limit the horizontal planes, the floor and the ceiling, will APPEAR TO CONVERGE TOWARDS THE CENTRE OF VISION C, as lines *c* C and *d* C, *a* C, and *b* C. But the horizontal planes of the floor and the ceiling, and the vertical planes, the side walls, are all perpendicular to the plane of the picture, so the lines of intersection of those planes must also be perpendicular to the plane of the picture. We may assert, therefore, that as all PLANES *that are perpendicular* to the plane of delineation, converge towards either the horizontal line or the central vertical line, so all LINES THAT ARE PERPENDICULAR TO THE PLANE OF THE PICTURE CONVERGE TOWARDS THE CENTRE OF VISION.

The point towards which planes or lines converge in perspective is called the VANISHING POINT of those planes or lines, therefore THE CENTRE OF VISION C, IS THE VANISHING POINT of lines that are perpendicular to the plane of the picture, whether such lines lie on horizontal or vertical planes.

If we suppose any number of lines drawn on the floor or ceiling parallel to the sides, or on the sides parallel to the floor and ceiling, all such lines must evidently be perpendicular to the plane of the picture, and parallel to each other, and

they might respectively represent the places of planes either horizontal or vertical, as at *e g h*, therefore the lines from *e g h* would be subject to the same laws as lines from *a b c d*, that is, being all perpendicular to the plane of the picture, they would all converge, or have their vanishing point in the centre of vision C. But if all those lines being parallel to each other, converge to the centre of vision, then it must follow, that ALL LINES THAT ARE PARALLEL CONVERGE TO, OR HAVE, THE SAME VANISHING POINT.

Let us add another *definition* to those already obtained.

9th. VANISHING POINTS, points to which lines appear to converge : C fig. 21, the centre of vision, is a vanishing point to lines *a* C, *b* C, &c., &c.

We may also add to the *deductions or axioms* previously stated.

7th. THAT ALL HORIZONTAL PLANES APPEAR TO CONVERGE TOWARDS THE HORIZONTAL LINE.

8th. THAT ALL VERTICAL PLANES THAT ARE PERPENDICULAR TO THE PLANE OF THE PICTURE, APPEAR TO CONVERGE TOWARDS THE CENTRAL VERTICAL LINE.

9th. THAT ALL LINES THAT ARE PERPENDICULAR TO THE PLANE OF THE PICTURE, CONVERGE TOWARDS, AND HAVE THEIR VANISHING POINTS IN, THE CENTRE OF VISION.

At this point of fig. 21 we have obtained the four planes, *a*, C, *b*—*a*, C, *c*—*c*, C, *d*, and *b*, C, *d*, but those planes have limits only in their width, that is to say, although the *width* of the floor and ceiling, and the *height* of the walls are determined, the *length* of the room is still undetermined. Let us endeavour to find a means then of cutting off as much of the lines *a*, C, &c., &c., as will express the required length of the room, and we will assume the *real* length to be equal to the line *c, d*, that is, equal to the width.

In fig. 20 we explained the nature of the base line B, and the fact that the space 2, 2, in that figure was the representative of the plane of the picture, *a, b, c, d*. We have in fig. 21 a base line B, and the space 2, 2, upon it. We have asserted

that the floor, walls, and ceiling of the room, fig. 21, touched the plane of the picture, and that the floor, walls and ceiling, were perpendicular to that plane. But 2, 2, being equal to *a b*, and vertically over, and correspondent with, the plane *a, b, c, d*, represents truly the front edge of the floor, therefore if we draw at 2, 2, lines perpendicular to line 2, 2, they will represent, *geometrically*, the lines of the walls, and if we determine their length and join their extremities, we shall have a GEOMETRICAL PLAN OF THE ROOM, as at 2, 3, 4, 2, and as we have determined the length of the room to be equal to its width, 2, 3, 4, 2, will of course be a square.

We have asserted that the walls of the room, being perpendicular to the plane of the picture, have their vanishing point in C, the lines 2, 3, and 2, 4, represent geometrically those walls, therefore the lines 2, 3, and 2, 4, have their vanishing point in C. Let us remember, as explained in fig. 20, that in connection with the base line and the plan connected with it, C represents the true *station point of the eye* and that *we are now dealing with facts* in order *to imitate appearances*.

We will now draw a line from C, *parallel to line* 2, 3, line 2, 3, being perpendicular to the base line B, and line B being parallel to the horizontal line C, H; a line from C, perpendicular to line H, must be parallel to line 2, 3; a line drawn from C, parallel to line 2, 3, will therefore cut the base line B, in P. Line 2, 4, is also perpendicular to line B, and therefore parallel to line 2, 3, if we draw a line from C, parallel to line 2, 4, it will coincide with line B P. But P is immediately over or perpendicular to C, therefore if we transfer the point P, on the base line, to the horizontal line H, it will coincide with point C, but C is the *Vanishing Point* of lines 2, 3, and 2, 4; therefore, BY DRAWING A LINE FROM C, THE STATION POINT OF THE EYE, PARALLEL TO A LINE AS 2, 3, OR 2, 4, IN THE GEOMETRIC PLAN, WE MAY OBTAIN A POINT P ON THE BASE LINE B, WHICH POINT PERPENDICULARLY TRANSFERRED TO THE HORIZONTAL LINE, WILL GIVE THE VANISHING POINT OF SUCH LINE 2, 3, OR 2, 4.

Let us now draw a diagonal of the plan of the room, this plan being square, such line will be the diagonal of a square, as line 2, 3. One extremity of line 2, 3, being placed at 2, one of the nearest angles of the floor, the other extremity 3 will lie upon one of the distant angles of the floor, and it will be evident that, if we can succeed in drawing the *Perspective representative* of line 2, 3, we shall obtain the limit of the floor in Perspective, but in order to draw this *Perspective representative* of the *geometric* line, 2, 3, we must find its *vanishing point.* We will therefore draw a line from C, parallel to line 2, 3, cutting the base line in V, and transferring point V, to the horizontal line H, we obtain the vanishing point of line 2, 3. But point V, transferred to the horizontal line, will coincide with point D, the point of distance, because line 2, 3, is the diagonal of a square, the sides of which are parallel to lines H, and C, P, therefore a line drawn from C, parallel to line 2, 3, will cut line B, at a distance from P, equal to the distance P, C, line C, V, is therefore the diagonal of a square, of which C, P, is the side, line P, V, is then equal to line P, C, but line C, D, is equal to line C, P, and therefore equal to line P, V; therefore THE POINT OF DISTANCE IS THE VANISHING POINT OF THE DIAGONALS OF SQUARES WHEN THE SIDES OF SUCH SQUARES ARE PARALLEL AND PERPENDICULAR TO THE BASE LINE.

Let us then draw a line from *d*, to D, cutting the line *c*, C, in *i*. But if the plan, 2, 3, 4, 2, represent the floor, it will also represent the ceiling, and the diagonal, 2, 3, may then be the diagonal of the ceiling; let us therefore draw a line from *b* the near angle of the ceiling, to D, and we shall cut the line *a*, C, in *k*, determining thereby one of the distant angles of the ceiling, and if we join *i*, *k*, we shall define one of the side walls of the room, as *a*, *c*, *k*, *i*.

Now let us repeat the process on the other side, that is, let us imagine a second diagonal drawn from 2 to 4, and the vanishing point found as before; for the same reason that the vanishing point of 2, 3, coincided with one point of distance, so necessarily would the vanishing point of the new diagonal

coincide with the other point of distance, therefore draw a line from C, to D 2, and from *a* to D 2, cutting lines *b*, C, and *d*, C, in *l* and *m*, and we obtain the limits of the wall *d*, *b*, *l*, *m*, and by joining *l*, *k*, and *m*, *i*, the limits of the ceiling and the floor are found, and the extent of the room defined, the representation or perspective drawing coinciding precisely with the appearance of a room of which 2, 3, 4, 2, is a geometric plan, such room being seen from C.

Let us now examine the representation, commencing with the floor; two of its lines *c i*, and *d m*, visibly converge towards a vanishing point, although we know that they are really parallel, as at 2, 3, and 2, 4; but, if we test the two lines *c d*, and *m i*, we shall find that those lines remain parallel to each other, as in the plan at 2, 2, and 3, 4; but if those lines continue parallel, they can have no vanishing point; let us endeavour to ascertain whether the process by which we obtained the vanishing point of line 2, 3, will furnish us with a vanishing point for 2, 2, and 3, 4. The vanishing point of line 2, 3, was obtained by drawing a line from C, parallel to 2, 3, and cutting the base-line in V; but if we draw a line *from* C, parallel to either of the lines 2, 2, or 3, 4, such line can never cut the base-line, because lines 2, 2, and 3, 4, are both parallel to it, the base-line; therefore, a line drawn from C, parallel to 2, 2, and 3, 4, would also be parallel to the base-line, and therefore could never cut it. But the vanishing point of line, 2, 3, was obtained by transferring *v*, the point of intersection of C *v*, with the base line to the horizontal line, but as we have seen a line from C parallel to 2, 2, and 3, 4, would *not intersect the base line*, therefore, we should obtain no point of intersection to transfer to the horizontal line, and therefore, the lines *c d*, and *m i, can have no vanishing point.*

We have before shown that lines that are parallel to each other converge to the same vanishing point.

The diagonals of a square, make with the sides, angles of 45°: the vanishing points of the diagonals 2, 4 or 2, 3, of

the square 2, 3, 4, 2, or *a b l k*, or *c d m i*, ARE THE POINTS OF DISTANCE, THESE ARE THEREFORE THE VANISHING POINTS OF ALL LINES MAKING AN ANGLE OF 45° WITH THE PLANE OF THE PICTURE.

The real use of the vanishing point D, of the diagonal 2,3, was to determine the length of the perspective line *c* C, in other words to *measure* upon the line *c* C, a length perspectively equal to the line *c d*. THE POINT OF DISTANCE, D, IS THEREFORE THE MEASURING POINT OF ALL LINES WHICH ARE PERPENDICULAR TO THE PLANE OF THE PICTURE. Thus, if a line be drawn from *t* to D 2, it will cut line *b* C, in *n*. Line *t n* will be the diagonal of a square of which *b t* is the side, and *b n* will be perspectively equal to *b t*, and so of any lines drawn from any points on the lines *a b*, and *c d*. THE POINTS OF DISTANCE ARE THE MEASURING POINTS OF DISTANCES INTO THE PICTURE.*

We have before observed that, as shown in the plan, one end of the room is supposed to touch the plane of the picture, just as though the end had been taken out and a transparent plane placed in its stead; it would follow therefore, that the dimensions or surfaces of objects which touch this transparent plane, will undergo no diminution, that is, they will be represented in the perspective drawing the same

* All measurements are obtained in Perspective by means of Isosceles triangles; thus the required length of the line 2, 3, being known, is one given side of the triangle, a line equal in length to 2, 3, is set off on the base line as line 2, 2, and the extremities of lines 2, 3, and 2, 2, are joined, forming an Isosceles triangle, of which the given line 2, 3, is the side, and the diagonal line 2, 3, the base. In the perspective drawing we have the line *c, d*, the measured *side* of the triangle 2, 3, 2; the line *c*, C, the indefinite side, *to be measured;* and the line from *d* drawn to its vanishing point, cutting the indefinite side of the triangle *c* C in *i*—lines *c, i*, and *c, d*, being the sides, and line *d, i*, the base of the Isosceles triangle represented in plan at 2, 3, 2.

C is therefore the vanishing point of one *side* of the Isosceles triangle *c, i, d*, and D is the vanishing point of the *base* of that triangle—the length of the base, commencing from the known angle *d*, determines of course the length of the unknown side *c, i*, and the *vanishing point* of *d, i*, is therefore the *measuring point* of *c, i*.

size as they appear in the plan, as line *c d* is equal to line 2, 2, but as objects recede from the transparent plane and therefore from the base line, as line 3, 4, they appear to diminish as line *i m*, and the same law applies to vertical lines, as line *c a* and *i k*, therefore, any dimensions which are set off on the plane of the picture, *a b c d, are geometric or real dimensions, and such dimensions can only be found or used upon the plane of the picture.*

We may add the deduction—

10. THAT, THE VANISHING POINT OF ANY LINE LYING UPON A HORIZONTAL PLANE, AND REPRESENTED IN PLAN, MAY BE OBTAINED BY DRAWING A LINE FROM THE STATION POINT OF THE EYE, PARALLEL TO SUCH LINE, TO CUT THE BASE LINE OF THE PLAN, AND BY THE TRANSFERRING OF SUCH POINT OF INTERSECTION TO THE HORIZONTAL LINE, AS SHOWN AT C V, FIG. 21.

11. THAT, THE POINTS OF DISTANCE ARE THE VANISHING POINTS OF THE DIAGONALS OF HORIZONTAL SQUARES WHOSE SIDES ARE PERPENDICULAR AND PARALLEL TO THE PLANE OF THE PICTURE, AND THEREFORE OF ALL LINES LYING ON HORIZONTAL PLANES WHICH MAKE ANGLES OF 45° WITH THE PLANE OF THE PICTURE.

12. THAT, AS THE CENTRE OF VISION IS THE VANISHING POINT OF ALL LINES PERPENDICULAR TO THE PLANE OF THE PICTURE, SO THE POINTS OF DISTANCE ARE THE MEASURING POINTS OF ALL SUCH LINES. OR THAT, ALL LINES THAT HAVE THE CENTRE OF VISION AS A VANISHING POINT HAVE THE POINT OF DISTANCE AS A MEASURING POINT.

13. THAT, ALL DIMENSIONS OR MEASUREMENTS SET OFF UPON THE PLANE OF THE PICTURE ARE GEOMETRIC, OR REAL DIMENSIONS, AND THAT REAL DIMENSIONS CAN ONLY BE OBTAINED OR USED IN THE PERSPECTIVE DRAWING UPON THAT PLANE.

Before commencing the use of the knowledge which we have now obtained, let us recur to fig. 21 for a few moments.

We have previously asserted that *rays* pass from every

portion of an object or objects to the eye. Let us then draw lines from C, the station point of the eye, to 3 and 4, the distant angles of the square, such lines will represent rays, and will cut the base line in 5 and 6. If from 5 and 6 we drop perpendiculars, such perpendiculars will cut the perspective lines *a* C and *b* C in *l* and *k*; in other words, they will give the perpendiculars *l m* and *k i*, and determine the length of the room, we might therefore have completed the room by this method without the use of the points of distance, and by this method the length of any line may be determined in the picture, as if we set off from 2 on the line 2, 4 a length equal to *b*, *t*, as 2, 7 drawing a line from C to 7 cutting the base line in 8 and dropping a perpendicular from 8, it will cut line *a* C in *n*.

These two methods are thus shown together in order that they may illustrate and verify each other.

Let us proceed to use the Centre of Vision as a Vanishing Point, and the Point of Distance as a Measuring Point.

Plate I.

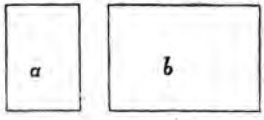
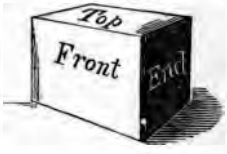


Fig I.

Fig II.



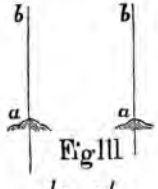


Fig III

Fig IV

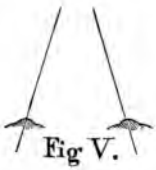


Fig V.

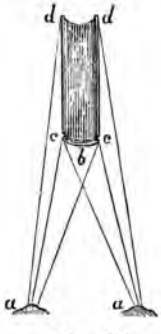


Fig VI.

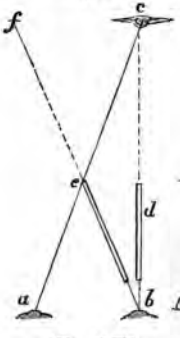


Fig VII.

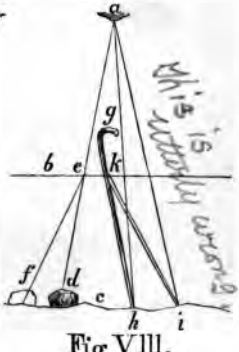


Fig VIII.

Fig IX.

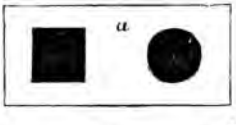


Fig X.

Fig XI.

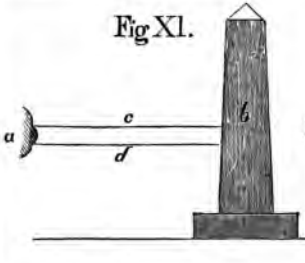


Fig XII.

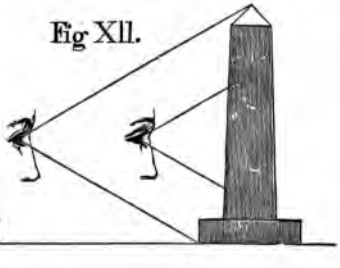


Plate III.

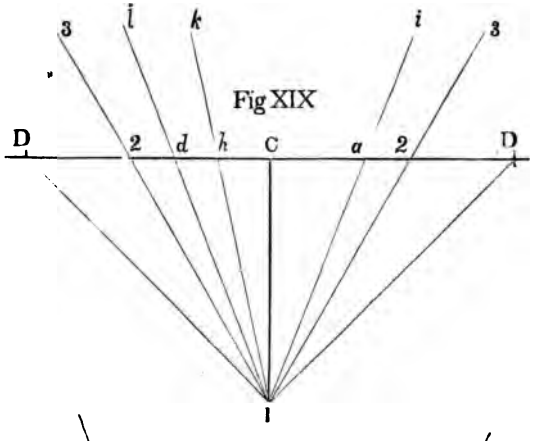


Fig XIX

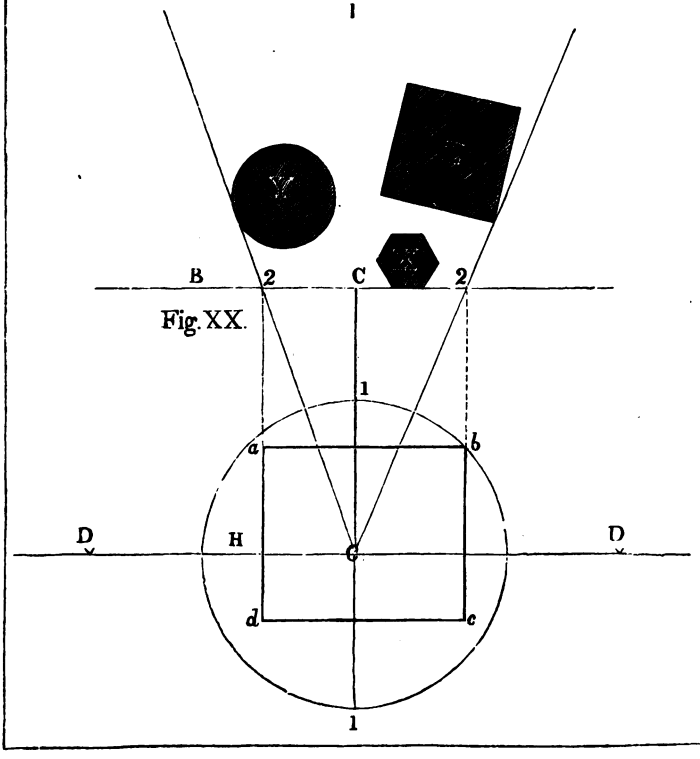
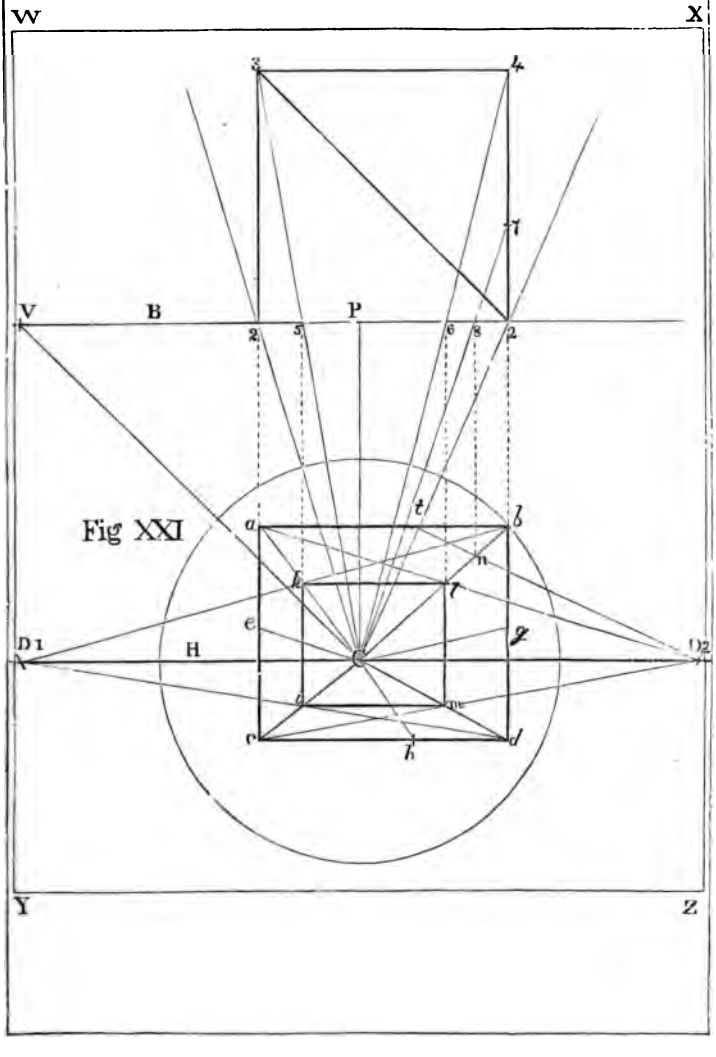


Fig. XX.

Plate IV



LESSON IV.

LET *a b c d*, fig. 22, plate 5, represent a given plane of delineation ; C, the Centre of Vision ; H, the Horizontal Line ; D 1, and D 2, the Points of Distance obtained as shown in fig. 20; and *a b* the Picture or Ground Line.

The space lying between the Ground Line *a b* and the Horizontal Line H we will suppose to be equal to, or the representative of, five feet, about the usual height of the eye from the ground or plane on which we stand, called the GROUND PLANE, and sometimes the ORIGINAL PLANE. We have shown that all dimensions set off on the plane of the picture are geometric, or real dimensions, we will therefore divide that portion of the vertical edge of the picture lying between *a* and the Horizontal Line into five equal parts, as 1 2 3 4 5, and thus obtain a SCALE. By this scale the Ground Line (*a b*) will be found to be 15 feet 6 inches long, and the Vertical Line (*a c*) 13 feet 4 inches high.

Let us construct a room 15 feet 6 inches wide, 13 feet 4 inches high and 25 feet long.

From *a* and *b*, which are 15 feet 6 inches apart, draw lines to the centre of vision C.

From *c* and *d*, which are 13 feet 4 inches from *a* and *b* and 15 feet 6 inches from each other, draw lines also to C.

The given length of the room is 25 feet. Produce therefore the Picture Line *a b* in the direction *e*, making *a e* equal to 25 feet by the scale previously obtained.

Draw a line from *e* to D 1, cutting line *a* C in *f*, and *a f* will be the representative, or perspective appearance, of 25 feet.

From *f* draw lines parallel to lines *a b* and *a c* cutting lines *b* C and *c* C in *g* and *h*.

From *g* and *h* draw lines parallel to lines *b d* and *c d*, cutting lines *d* C in *i*, and the skeleton of the interior of the room will be complete.

Upon the side of the room *b d g i* let us make an opening for doors, the nearest edge of the doorway being 9 feet from the plane of the picture, the doorway to be 7 feet wide and 10 feet high.

From *b* set off on the picture line 9 feet in the direction of *a* as at 9.

Draw a line from 9 to D 2, cutting line *b g* in *k*—*b k* is equal to 9 feet.

From 9 on the Ground Line set off, towards *a*, 7 feet as at 7.

Draw a line from 7 to D 2, cutting line *b g* in *l*—*k l* is equal to 7 feet, the required opening of the doorway.

Erect perpendiculars at *k* and *l*.

From *b* set up on the vertical line *b d* 10 feet, the height of the doorway as at 10.

Draw a line from 10 to the centre of vision C, cutting the perpendicular from *k* and *l* in *m* and *n*—*k l m n* will be the required opening in the given position.—The line *b d* on the plane of the picture has been employed to give the height of the doorway; when any line on the plane of the picture is so employed it is called a LINE OF HEIGHTS.

On the side of the room *a c f h* let us construct two openings for windows, the nearest edge of the nearest opening being 4 feet from the plane of the picture—the opening of the windows each 4 feet, and the space between them 9 feet, the bottom of the opening being three feet from the ground plane, or the floor, and the openings 9 feet in height.

From *a* set off on the ground line 4 feet as at 4, from 4 set off a second 4 feet as at 8—from 8 set off 9 feet as at 17, and from 17 set off another 4 feet as at 21.

Draw lines from 4, 8, 17 and 21 to D 1, cutting line *a* C in *o p q r*.

At *o p q r* erect perpendiculars.

From *a* on the vertical line *a c* set up three feet as at 3—from 3 set up 9 feet as at 12.

Draw lines from 3 and 12, cutting the perpendiculars from *o p q r*, and the openings for windows are constructed.

In the centre of the end of the room, the plane *f g h i*, let us construct an opening for a fire-place 4 feet wide and 4 feet high.

To obtain the centre of the end, bisect line *f g* as at *s*.

From C draw a line through *s* and produce it to cut the ground line as at *t*—from *t* set off on each side 2 feet as at 2, 2.

Draw lines from 2, 2 to C, cutting line *f g* in *u* and *v*—*u v* will be equal to 4 feet on the end of the room.—Erect perpendiculars at *u* and *v* equal to *u v*—join their extremities, and the opening for the fire-place will be constructed of the required size.

From the *centre* of the ceiling, let us drop a perpendicular line 5 feet in length.

For the centre of the ceiling, draw the two diagonals *c i* and *d h*, cutting in *w*, which is the centre. Draw a line from C through *w*, producing it to cut line *c d* in *x*. From *x* drop a perpendicular equal to 5 feet by the scale, as *x y*. Drop a perpendicular from *w*. Draw a line from *y* to C, cutting the perpendicular from *w* in *z*; *w z* will be the line required of the given length. Line *x y* is a *Line of Heights* for line *w z*.

Four feet from the left side of the room and 13 feet within it, let us erect a perpendicular 6 feet in height, which may represent a man.

From 4 (equal to 4 feet from *a*) draw a line to C. From 17 (equal to 13 feet from 4) a line is already drawn intersecting the line last drawn from 4 in *a'*. At 4 erect a perpendicular equal to 6 feet by the scale, as 4, 6. Erect a perpendicular at *a'*. Draw a line from 6 to C, cutting the perpendicular from *a'* in *b'*. Line *a' b'* is the line required of the given height.

It will have been observed that, the construction of doorway, windows, fire-place, line from ceiling, and line from floor, have all been obtained by the repetition of the same process, but there is one feature which it may be necessary to call attention to. In measuring distances into the picture, that extremity of the line required to be cut, which touches the plane of the picture, must always be used as the starting point of the measurement on the picture line from which the line is required to be drawn to the distance, or measuring point: thus to determine the position of the man, 4 feet was set off from *a* and a line drawn from 4 to C. From 4, 13 feet was set off, as at 17, 13 feet being the required distance within the picture, and from 17 a line drawn to the measuring point, thus cutting 13 feet off the line 4 C.

H
DI.
5
4
3
2
1
7
a.

LESSON V.

PLATE 6, FIG. 23.

LET C be the centre of vision, H the horizontal line, D 1 and D 2 the points of distance, obtained as before, *a b* the picture or ground line, the vertical line *a* 5, divided into five equal parts, as a scale, all as in fig. 22.

Let us construct a square lying on the ground plane, its front edge lying parallel to the plane of delineation and touching it, having the seat of one of its angles at *a*, each of its sides being 8 feet in length.

Proceed as in the last fig., that is, from *a* set off 8 feet on the picture line, as at 8.

Draw lines *a* C, 8 C.

From 8 on the picture line, draw a line to D 1, cutting line *a* C in 8.

From this point of intersection, draw a line parallel to *a* 8, cutting 8 C in 8.

The square *a*, 8, 8, 8, will be the required square lying on the ground plane.

Let us, upon this square, construct a solid block, say of stone, 2 feet in height.

At *a* and 8, on the picture line, erect perpendiculars 2 feet high, as *a* 2, 8, 2.

Draw line 2, 2, parallel to the picture line. Parallelogram *a*, 2, 8, 2, is the front face of the proposed block.

From 2 and 2, draw lines to C.

From the distant angles of the square on the ground plane

as 8, 8, erect perpendiculars cutting the lines 2 C, 2 C in 2 and 2.

Join the two points last obtained, as 2, 2. The square 2, 2, 2, 2, is the upper face, and parallelogram 8, 8, 2, 2, the side face of the proposed block.

Upon the square 2, 2, 2, 2, let us inscribe a square having each of its sides 6 feet in length, and parallel to and equidistant from, the sides of the square 2, 2, 2, 2.

Draw the diagonals of the square 2, 2, 2, 2.

From the angles 2, 2, of the *front* edge of the square, set off 1 foot as at 1, 1.

Draw lines from 1, 1, to C, cutting the diagonals in 3, 3, 3, 3.

Join points 3, 3, 3, 3, and a square having sides of 6 feet and lying one foot within the picture will be obtained; its sides will also be parallel to, and equidistant from, the sides of the square 2, 2, 2, 2.

Upon the square 3, 3, 3, 3, let us construct a block of stone 7 feet in height.

Erect a perpendicular at 1, 7 feet in height by the scale, as 1, 7.

Draw line 7 C. Line 1, 7, being on the plane of delineation will be a geometrical height, it will be a line of heights for the block to be constructed on 3, 3, 3, 3.

Erect a perpendicular at the angle of the square 3, 3, 3, 3, adjacent to the perpendicular 1, 7, cutting the line 7 C in 4. Perpendicular 3, 4, will be 7 feet in height, 1 foot within the picture, therefore,

From 4, draw a line parallel to the horizontal line, and erect a perpendicular from the other nearest angle 3, to cut it as in 4.

Draw lines from the points 4 to C, as lines 4 C, 4 C.

Erect perpendiculars from the distant points 3, 3, cutting the lines 4 C, 4 C in 4 and 4. The two vertical planes 3 4, 3 4, are the two *visible* sides of the block; the square 4, 4, 4, 4, is the top, of which, although *invisible*, we will proceed to make use, by drawing upon *it* a square having sides of 4 feet,

and each side parallel to, and equidistant from, the sides 4, 4, 4, 4. In fact a repetition of the process by which we obtained the square 3, 3, 3, 3.

Draw the diagonals 4, 4, 4, 4, as before.

Draw a line from 7 parallel to the horizontal line, this line will lie upon the plane of the picture, and therefore upon it geometrical dimensions may be set off. Set off therefore from 7, 1 foot as at 1, and 5 feet as at 5.

Draw lines from 1 and 5 to C, cutting the diagonals 4, 4, 4, 4, in 5, 5, 5, 5.

Join 5, 5, 5, 5, and a square, having sides of 4 feet and lying 2 feet within the picture will be obtained, its sides will also have the given relation to the square 4, 4, 4, 4.

Join the angles 5, 5, 5, 5, to the angles 3, 3, 3, 3, and we obtain a block of a pyramidal character.

Let us now regard the square 4, 4, 4, 4, as lying upon the top of this block, and upon 4, 4, 4, 4, we will proceed to construct a covering which shall be at first a flat tile 2 feet in thickness.

Set up, therefore, from 7, on the vertical line 1, 7; 2 feet as at 2.

Draw a line from 2 to C.

Set up a perpendicular from the angle of the square 4,4,4,4, adjacent to 7 and cutting the line, drawn from 2 in the direction of C, in 6.

Draw a horizontal line from 6, and a perpendicular from the second angle of square 4, 4, 4, 4, to cut in 6.

From the point last obtained, draw a line to C.

Erect a perpendicular at the third angle of the square 4, 4, 4, 4, cutting the last line in 6.

The two visible sides of the tile are now completed, the tile being the given size and occupying the required position relative to the square 3, 3, 3, 3, that is, it is 6 feet square, and 1 foot within the picture, it is also 2 feet in thickness.

Let us now proceed to cut this tile into a more ornamental shape, as shown in the *geometric elevation at* Z, on which the dimensions are figured.

From 2, draw a horizontal line and produce it indefinitely.

On the vertical line 7, 2, set off the sub-divisions on the line *x*, *x*. On the horizontal line 2, set off the sub-divisions on the line *x*, *y*, as at *l*, *m*, *n*, *o*; the vertical line 7, 2, and the horizontal line 2, are both on the plane of the picture, therefore the dimensions set off upon them are geometric.

Draw lines from the subdivisions on 7, 2, to C, cutting the vertical edge of the tile.

Draw lines from *l*, *m*, *n*, to C, cutting the upper horizontal edge of the tile; the geometric dimensions of the elevation at Z will now be transferred 1 foot within the picture to the front plane of the tile; draw vertical and horizontal lines upon this plane from the obtained points, and complete the front plane by drawing lines from the intersecting points as in the elevation.

To complete the edge of the tile *perpendicular* to the plane of the *picture*.

From D 1 draw a line through 6, the angle of the tile, cutting the produced horizontal line from 2 in *s*.

From *s* set off the subdivisions on line *x*, *y*, as at *t*, *u*, *v*.

From *t*, *u*, *v*, draw lines to D 1, cutting the *upper edge* of the face of the tile perpendicular to the plane of the picture.

Drop perpendiculars from the divisions obtained on the line 6 C.

From the divisions already obtained on the *vertical edge* of this face, draw lines to C.

From the points of intersection thus obtained, draw lines as in the front face to complete the side.

We will now complete the tile, by drawing lines from the angles on its two visible faces to a central vertex, which shall be eighteen inches above the upper horizontal face of the tile.

To obtain a central vertical line, perpendicular to the face of the tile, we may erect a perpendicular upon the intersection of the diagonals of any of the squares, whether 8, 3, 4, or 5.

To determine its height, set up a perpendicular at *m* equal

to 1 foot 6 inches, as *m*, *p* ; draw a line from *p* to C, cutting the perpendicular from the intersection of the diagonals in *q*.

Draw lines from *q* to the angles on the two visible faces of the tile, and thus complete the figure.

If the student has followed step by step the work, he will see that the result is obtained by a repetition of the process by which fig. 22 was drawn ; that is, by placing horizontal and vertical planes in perspective, and obtaining measurements upon them, using only the centre of vision as a *vanishing point*, and the point of distance as a *measuring point*. The lines 3, 5, the angular lines forming the edge of the tile, and the converging lines forming its top, being the only *lines* which have not their representatives in fig. 22.

LESSON VI.

PLATE 6, FIG. 24.

LET us construct a slab 10 feet square and 2 feet 6 inches thick, its sides parallel and perpendicular to the plane of the picture, lying upon the ground plane, 4 feet within the picture, and 4 feet to the right of the central vertical line.

It is hoped that no instruction is now necessary to enable the student to do this—the dimensions are, however, left figured upon the drawing.

Upon this base or plinth let us erect an *octagonal* shaft 12 feet high, the diameter of the shaft being 6 feet. The shaft to be covered by an *octagonal* tile 10 feet in diameter and 2 feet thick.

Four of the sides of the shaft to be parallel to, and equidistant from, the *sides* of the square plinth, and four parallel to its *diagonals*. The sides of the tile being parallel to, and equidistant from, the sides of the shaft.

Construct below the picture line a half plan of the *circumscribing square* of the larger octagon, the tile, and of the circumscribing square of the smaller octagon, the shaft, placing them in proper relation to each other and to the square plinth, and inscribe upon each half square the half of the octagon belonging to it, as at 4, 10, where 4 *x*, 10 *x*, is the half square of the larger octagon, and *y*, *z*, *y*, *z*, the half square of the smaller.*

* To construct the larger semi-octagon. From X and X with X *u* as radius, describe arcs, cutting line X X in *o*, *o*. From *o* and *o* draw lines parallel to the opposite diagonals X *u*. Obtain the smaller semi-octagon in a similar manner.

The square *a*, *a*, *a*, *a*, is the upper plane of the plinth, its front edge *a*, *a*, lying within the picture: the smaller square requires to be transferred to this plane.

Draw a diagonal of the plane *a*, *a*, *a*, *a*.

Draw lines from *y*, *y* to C, cutting the *lower* edge of the front plane of the plinth, from those erect perpendiculars cutting the *upper* edge, and from those points draw lines to C, cutting the diagonal of *a*, *a*, *a*, *a*, in 1, 1, 1, 1. Complete the square 1, 1, 1, 1, by drawing the two horizontal lines 1, 1, and 1, 1.

From the angles *w*, *w*, of the plan draw perpendiculars to the picture line, carry them back to the lower edge of the plinth, erect perpendiculars, cutting the upper edge of the plinth, draw lines from these points to C, cutting the two sides of the square 1, 1, 1, 1, in 2, 2, 2, 2. This is merely a repetition of the process by which the square 1, 1, 1, 1, was obtained.

The horizontal lines 2, 2, and 2, 2, are two sides of the octagon *parallel* to the plane of the picture, and some portion of the two converging lines 1, 1, will be the two sides which are *perpendicular* to the plane of the picture.

The four remaining sides of the octagon will be *parallel* to the diagonals of the square, therefore they will converge to the same vanishing points, but the points of distance are the vanishing points of these diagonals, therefore,

From the left extremity of the nearest line 2 draw a line to D 1, cutting line 1, 1, in 3.

From the right extremity of the same line draw a line to D 2, cutting line 1, 1, in 4.

From D 2 draw a line through the left extremity of the distant line 2, *producing it to the left* to cut line 1, 1, in 5.

From D 1 draw a line through the right extremity of the distant line 2, 2, *producing it to the right* to cut line 1, 1, in 6.

2, 3, 5, 2, 2, 6, 4, 2, will be the plan of the octagonal shaft.

To determine the height of the shaft, from the point where the perpendicular from *w*, one of the angles of the

plan, cuts the picture line as at *v*, set up a perpendicular 14 feet 6 inches high; this line is on the picture plane, and is a line of heights for the shaft; it contains 2 feet 6 for the plinth, and 12 for the shaft, as at 14—6. Draw a line from its upper extremity to C.

At 2, the left extremity of the nearest line 2, 2, erect a perpendicular, cutting the line 14, C in 7.

From 7 draw a horizontal line to the right.

Erect a perpendicular from the right extremity of the nearest line 2, 2, cutting the horizontal line from 7 in 8.—2, 7, 8, 2, will be the near face of the octagonal shaft.

From 7 draw a line to D 1; from 3 erect a perpendicular, cutting this line in 9.—2, 7, 9, 3, will be a side parallel to one of the diagonals of the square.

From 9 draw a line to C; from 5 erect a perpendicular cutting this line in *d*.—3, 9, *d*, 5, will be a side perpendicular to the plane of the picture.

From 8 draw a line to D 2; from 4 erect a perpendicular cutting this line in *e*.—2, 8, *e*, 4, will be a side parallel to the second diagonal; it will be the last visible side of the shaft.

We proceed to place the circumscribing square of the octagonal tile in its position.

At 14—6 draw a horizontal line, transferring to it, perpendicularly, the points *x*, *o*, *o*, *x*, from the plan, as at 1′, 2′, 3′, and 4′.

Draw line 1′ C. From *a*, the left angle of front plane of the plinth, erect a perpendicular, cutting line 1′ C in 5′.

From 4′ draw a line to C; from 5′ draw a horizontal line, cutting this line in 6′.—Line 5′, 6′, will be the near side of the circumscribing square for tile; complete the square and draw through it the lines 2′ C, 3′ C, all as in the plan for the shaft, drawing lines from the obtained points to the proper vanishing points, all as before, completing the lower plane of the tile as at *a*′, *b*′, *c*′, *d*′, *e*′, *f*′.

We have now to construct the thickness of the tile, which was required to be 2 feet.

At 2′ set up a perpendicular 2 feet by scale, as 2′, 2″, bearing in mind that the horizontal line 1′, 4′, and therefore the vertical line 2′, 2″, is on the Picture Plane.

From 2″ draw a line to C; from *a′*, one of the front angles of the tile, set up a perpendicular cutting the last line in 1″.

From 1″ draw a horizontal line, and cut it by a perpendicular from *b′* in 3″. *a′*, 1″, 3″, *b′*, will be the front face of the tile; complete it by drawing from 1″ a line to D 1, cutting it by a a perpendicular from *c′*, in 5″; from 3″ a line to D 2, cutting it by a perpendicular from *d′* in 4″; from 5″ a line to C cutting it by a perpendicular from *e′* in 6″; this will complete the visible sides of the tile.

To complete the upper plane of the tile, let us find a point 3 feet above its centre, and draw lines from this point to its angles.

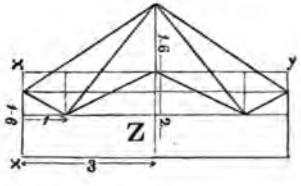
At 2″ draw a horizontal line; transfer to this line the point *u* in the plan; representing the centre of the front plane of the tile projected to the plane of the picture, as 7″; at 7″ erect a perpendicular equal to 3 feet by scale, from its extremity draw a line to C. Find the centre of the tile, either of its upper or lower plane as convenient, by the intersection of the diagonals of the circumscribing square, as at S. From S erect a perpendicular, cutting the line drawn from 3 feet to C in 8″. Join 8″, 1″—8″, 3″—8″, 5″, and the work will be completed.

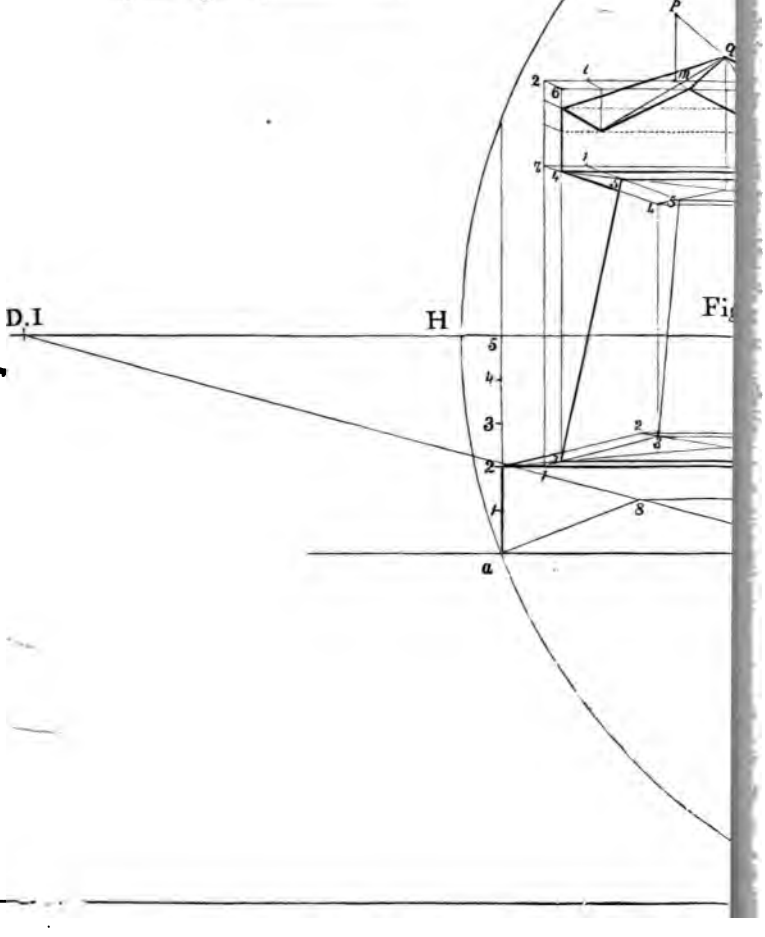
We have endeavoured in fig. 21 fully to explain the nature of the Centre of Vision as a *Vanishing Point*, or point of convergence, to lines and planes perpendicular to the plane of the picture; of the points of distance as the *Measuring Points* of all such lines or planes; and in fig. 22 we have applied this law to the placing in perspective certain horizontal and vertical planes of given dimensions, as the floor, ceiling, and walls, and obtaining upon those planes, other openings and points of given dimensions and in given positions, as the door, windows, and fire-place; we have also transferred a line of a given height to a given distance and position within the room, and suspended from a given point on the ceiling a line of a given length.

Now if the student has made this fig. 22 a subject of study, if he has thought as well as drawn, he will feel that he is now acquainted with a LAW which governs all planes either horizontal or vertical, which are perpendicular or parallel to the plane of the picture; and therefore any objects which are *composed of*, or *may be constructed from*, either horizontal or vertical planes perpendicular or parallel to the plane of the picture, will be subject to the same law, and can only demand an application of the same principle for their correct representation. The object represented in fig. 23 is, with exceptions to be noticed presently, composed of such planes—the plinth containing two horizontal planes, two vertical planes parallel to the plane of the picture, and two perpendicular to it. The upper face, or horizontal plane of the plinth having a smaller plane drawn upon it, a second plane, 4, 4, of the same size is placed directly above it, upon which a second smaller plane, 5, 5, is drawn; the adjacent angles of planes 3, 3, and 5, 5, are joined, and by so doing four planes 3, 5, 5, 3, are obtained, which are *not vertical* but *oblique planes*, they being neither parallel or perpendicular to the plane of the picture, but making oblique angles with the plane of the picture, and *also with the ground plane, although the edges* 3, 3, *and* 5, 5, *are parallel or perpendicular to the plane of the picture.* These oblique planes being the result of joining certain points on horizontal planes, the situations of which were found by the means adopted for finding measurements upon the floor or the ceiling in fig. 22. The oblique planes composing the upper surface of the tile were also obtained in a similar manner.

Fig. 23 gives therefore a METHOD OF APPLICATION of the *Law* endeavoured to be explained in Fig. 21, and an *Elementary Application* of which is given in fig. 22.

Fig. 24 presents us with an object composed of planes which are all either *vertical* or *horizontal*, except the top of the tile, *but some of which make oblique angles with the plane of the picture*, although they are perpendicular to the ground plane.


X
Y
f.6
6.f
f
Z
2
X
3


P
Q
2
6
1
7
4
5
D.I
H
5
4
3
2
1
a

The plinth of fig. 24 is a repetition of the plinth of fig. 23, except that it is removed a given distance within the picture; but upon the upper surface of this plinth a smaller octangular plane is drawn, and as those of its sides which are neither parallel nor perpendicular to the plane of the picture are parallel to the *diagonals* of the square plane of the plinth, so the point of distance, the vanishing point of this diagonal, becomes the vanishing point of those sides.

Fig. 24 gives therefore ANOTHER APPLICATION of the same law as employed in fig. 23, and containing in addition the use of the point of distance as a vanishing point.

The student is here then STRONGLY ADVISED to apply to other simple objects the knowledge which he has now acquired, before he proceeds to the next lesson, and if he has made each step his own as he has proceeded, it is hoped that he will find but little difficulty, and *much pleasure*, in thus exercising himself. We may suggest as one exercise the placing 8 squares, of different sizes, in perspective, in different positions upon the ground plane, and at different distances within the picture, and the erection upon those squares of upright posts of different heights—some of the squares having two of their sides and some one of their diagonals parallel to the plane of the picture. These posts may be ornamented according to the student's ability and zeal; many other simple and similar exercises will suggest themselves to every intelligent student.

LESSON VII.

PLATE 7, FIG. 25.

IN the three last lessons, the centre of vision has been employed as the vanishing point of lines perpendicular to the plane of the picture, and the points of distance, as measuring points for such lines. The point of distance has also been employed as a vanishing point of lines making certain oblique angles * with the plane of the picture; in the present lesson we propose to pursue this portion of the subject further.

In fig 21, the reason why the vanishing point of the diagonal, or the point of distance, became the measuring point of the centre of vision, was endeavoured to be explained; we shall repeat a portion of this in fig. 25, where C is the centre of vision; H the horizontal line; B the base line; C P the principal visual ray, all as in Fig. 21.—2, 3, 4, 2 is a square, having a diagonal 2, 4, a line C V parallel to such diagonal; the point *v* transferred to the horizontal line at D, also as in fig 21; *c d*, the side of the square, is transferred to the picture line and lines drawn from them to C; the length of the side of the square *c m* being determined as in fig. 21.

Taking up our inquiries at this point, let us ascertain how we found the vanishing point V of the diagonal. We have the horizontal line H, and the base line B, parallel to each other, and we require to draw a line from C parallel to the diagonal 2, 4, to cut the base line in V.

The diagonal 2, 4, makes with the base line, at its extremity

* Of 45 degrees.

2, an angle *a*, therefore, if we construct at C, on the horizontal line, an angle equal to angle *a*, as at angle *b*, and produce its side, it will cut line B in v, line C V, being parallel to line 2, 4. Let us construct *on the Base Line* at P the other extremity of the principal visual ray, an angle equal to angle *a*, as angle *c*, if we produce the side of this angle it will cut the horizontal line in D, a point we know to be immediately under *v*, and which has been obtained by transferring P V to C D; because point C is perpendicular to point P; angle *c* equal to angle *b*; and lines C H, and P B, are parallel; therefore point *v* will be perpendicular to point D. The result, therefore, is the same, whether a line be drawn from C *parallel* to line 2, 4, or an angle be constructed at P, equal to angle *a*, the latter method more readily obtaining the same result. Let us then find the vanishing point of the line 5, 6. Line 5, 6, makes an angle, *d*, with the base line; therefore, below and on the base line at P, construct an angle *e* equal to angle *d*, and produce its side until it cut the horizontal line in V;—and this will be the vanishing point of line 5, 6. If, then, we transfer the point 5 to the picture line, as at *f*, and draw the line *f* V, we shall have obtained a line, a *portion* of which will represent the line 5, 6. The line P V, being in every respect equal to the line C U, just as P D is equal to C *v*.

In the square 2, 4, 3, 2, the line C P represents the *edge of the Vanishing Plane* of the lines 2, 3, and 2, 4, and the length of this line C P, being transferred to the horizontal line as at D, becomes the *Measuring Point* of the lines C *c*, and C *d*. Thus, if, from C as centre, with C P as radius, we describe the arc P, D, we obtain the measuring point D. Therefore, if from a vanishing point as C, with the edge of the vanishing plane, line C P, as radius, we describe an arc cutting the horizontal line as in D, we obtain a *measuring point* for such vanishing point. But line C U, is the edge of the vanishing plane of line 5, 6, and line V P, is equal to line C U, and V is the vanishing point of line 5, 6; therefore, if from V, as

centre, with V P as radius, we describe an arc cutting the horizontal line, we shall obtain the *measuring point* of the line 5, 6, as at M.

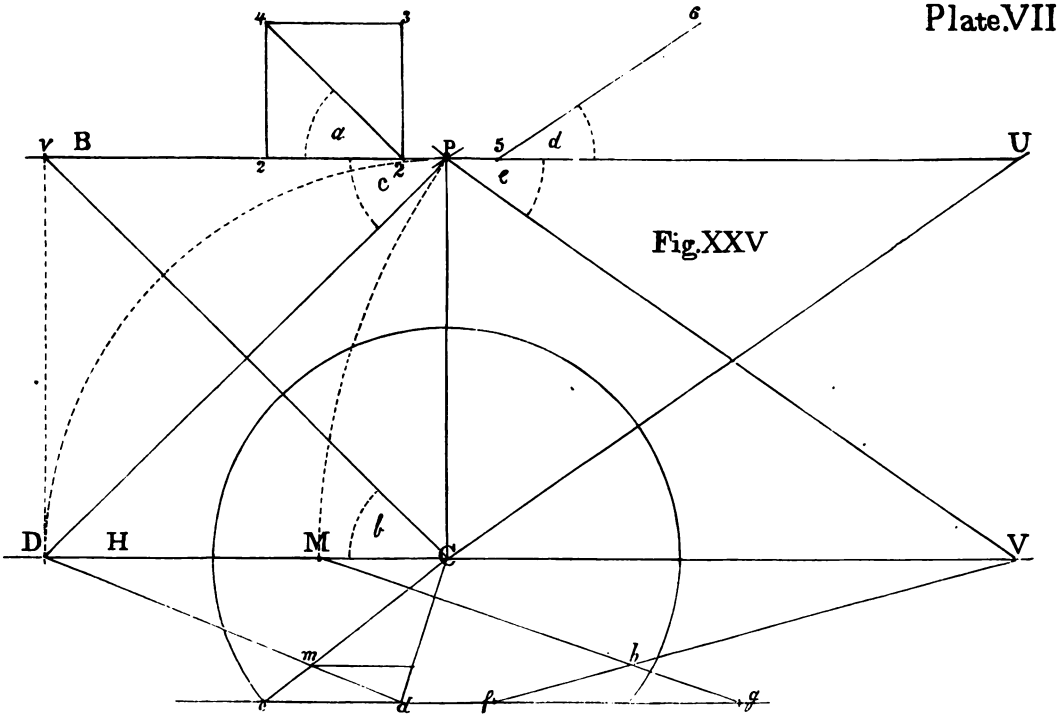
In order to make use of the measuring point D, to determine the required length of the line *c*, C, we set off *upon the picture line*, the *geometric* length of the line 2, 4, as at *c*, *d*, drawing a line from *d*, to D, cutting line *c* C, in *m*. So, in order to determine the portion required of the line *f*, V, we must set off on the picture line (*which may be produced if required*) the *geometric line* 5, 6, as at *f*, *g*, drawing a line from *g*, to M, cutting line *f*, V, in *h*—*f*, *h*, being the perspective representative of the geometric line 5, 6.*

By this method then, the *vanishing points* of lines may be obtained whatever their positions with regard to the plane of the picture, and also the *measuring points* of such lines. The use of the measuring point being to transfer to perspective lines within the picture, the geometric dimensions set off upon the plane of the picture.

It is hoped that the student will here perceive that vanishing points and measuring points, whether they fall in the centre of vision and the point of distance, or anywhere else, depend upon one simple law, which is, that, *the vanishing plane is* a plane parallel to the plane of the object to which it belongs, one of its extremities or edges being coincident with the station of the spectator, the opposite cutting the plane of the picture, which may be produced if necessary, and the *measuring point is the length of the vanishing plane set off from the vanishing point.* Thus the line C P represents the vanishing plane of the lines 2, 4, and 2, 3: C D is equal to the length of that plane, D, is the measuring point of the vanishing point C; lines C U, or V P, represent the vanishing plane of the line 5, 6; V M is the length of that vanishing plane, M being the measuring point of line 5, 6.

* See also note, page 26.

Plate.VII



Let us proceed to fig. 26, plate 8, where C is the centre of vision, H the horizontal line, C P the principal visual ray, and G, the picture or ground line, 5 feet below the horizontal line.

It is proposed to place a square in perspective on the ground plane, one of its angles touching the plane of the picture, its sides making angles with that plane equal to the angles *a* and *b*, and each of its sides to be 10 feet in length.

At the extremity P of the principal visual ray, or line of direction, draw a line perpendicular to C P, as line *h h*.

At P, on line *h h*, construct angles equal to angles *a* and *b*, as *c* and *d*, producing their sides until they cut the horizontal line in V 1, and V 2. These will be the vanishing points of the sides of the square.

From V 1 with line V 1, P as radius, describe an arc cutting the horizontal line in M 1.

From V 2, with line V 2, P, as radius, describe an arc cutting the horizontal line in M 2.

M 1, and M 2, are respectively the measuring points of the vanishing points 1 and 2.

Let us assume *o* as the seat of the angle of the square touching the picture line.

Draw lines from *o*, to V 1, and V 2.

From *o* set off to the right and left, 10 feet by scale, as at 10 and 10, (the distance of the picture line from the horizontal line having been given as five).

From the 10 to the left draw a line to M 1, it will cut line *o* V 1 in *e*—*o e* will be 10 feet.

From the 10 to the right draw a line to M 2, it will cut line *o* V 2 in *f*—*o f* is 10 feet.

From *e* draw a line to V 2.

From *f* draw a line to V 1, and the square *o e g f*, is completed.

Let us construct a solid having *sides* 10 feet square upon this obtained square.

Erect a perpendicular at *o*, equal to 10 feet, as *o* 10.

Draw lines from 10 to V 1, and V 2.

Erect perpendiculars from *e* and *f*, to cut the lines last drawn in *i* and *k*.

From *i* draw a line to V 2, and from *k*, a line to V 1, intersecting in *l*—join *g l*, and the solid is completed.

Let us suppose the front *o*, *e*, *i*, 10, to be removed, and our purpose to be the representation of a *hollow* cube containing divisions—the thickness of the two vertical sides and the top, being each 1 foot—the shelves 6 inches in thickness—the first shelf being 3 feet, and the second 6 feet 6 inches, from the ground plane.

For the thickness of the vertical planes, set off from *o* and 10 on the picture line, 1 feet, as at 1, 1.

From 1 and 1 draw lines to M 1, cutting line *o* V 1 in *n n*.

Erect perpendiculars from *n* and *n*.

For the top, set off from 10 on the vertical line *o* 10, 1 foot, as at 1. Draw line 1, V 1 cutting the perpendiculars from *n* and *n* in *p p*.

From *n* and *p*, to the left, draw lines to V 2.

For the shelves, set up on the vertical line *o* 10, 3 feet and 6 inches, and 6 feet and 6 inches, as at 3, 6, and 6, 6.

From 3, 6, and 6, 6, draw lines to V 1, intersecting the perpendicular *n*, *p*. From two of those intersections, *q*, *q*, draw lines to V 2 for the upper and under sides of the two shelves.

Let us now place 6 feet from angle *o*, on the side *o*, f, another square adjacent to the first, each of its sides being 4 feet in length.

From *o*, set off 6 feet to the right, as at 6.

Draw a line from 6 to M 2, cutting line *o*, V 2 in *r*.

Draw a line from V 1 through *r*, producing it to the right.

Draw a line from M 1 through *r*, producing it to cut the picture line in *s*.

From *s* set off 4 feet to the right, as at *t*.

Draw a line from *t* to M 1, cutting the produced line drawn from V 1 through *r* in *u*.

Draw line *u*, V 2.

Draw a line from V 1 through *f*, and produce it to cut line *u*, V 2 in *v*; *u r f v* will be the required square.

Construct upon the obtained square a solid 10 feet high.

Erect a perpendicular at *r*, cutting 10 *k* in *w*.

Erect a perpendicular at *u*. Draw a line from V 1 through *w* to cut it in *x*.

Erect a perpendicular at *v*; draw line *x*, V 2 to cut it in *y*, when the visible portion of the solid will be completed.

The student's attention is directed to the fact that all lines having one vanishing point have also one measuring point, whatever their distance within the picture may be: thus line *r u* has the same vanishing point as line *o e*, one extremity of line *o e* touches the plane of the picture at *o*; the geometric length 10 feet is therefore set off from *o* as *o* 10, and a line drawn 10 to M 1; but line *r u* does *not touch* the plane of the picture, therefore a line is drawn from M 1 through the given extremity *r*, of the line *r u*, *this line being produced to cut the plane of the picture* in *s*, and from *s* the geometric 4 feet is set off as *s t*; a line is then drawn from *t* to M 1 cutting line *r* in *u*, the measuring of the line *r u* being thus performed.

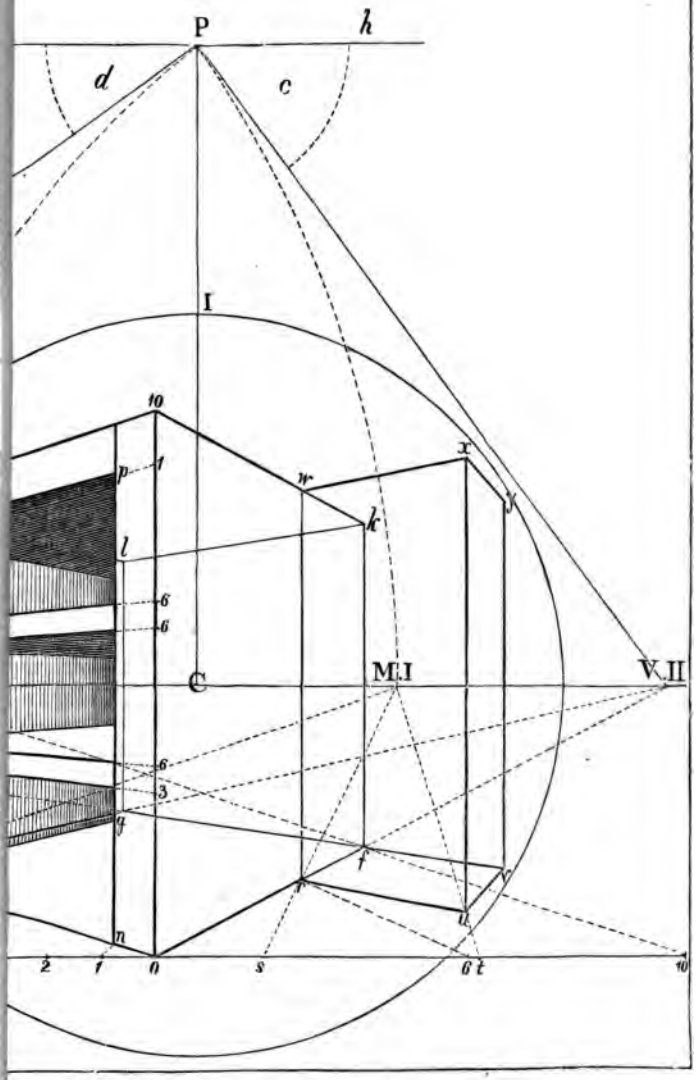
In this example, the circle the base of the cone of rays is described, the line C P, the principal visual ray, is erected, being the vertical height of an equilateral triangle of which the diameter of the circle would be the base; the point P being in fact obtained by describing arcs from the two extremities of the diameter with such diameter as radius: the distance between the measuring point and the vanishing point being equal to a line drawn from one extremity, P, of the principal visual ray to the produced picture plane, as line V 1, P, is set off from V 1 to M 1, and the angle by which we obtain the vanishing point is constructed at P, it will be evident, therefore, that *the finding the true length of the principal visual ray is* ESSENTIAL *to the true finding of every point employed.* Thus, suppose a point to be taken between C and P, that would shorten the principal

visual ray, this would contract the base of the cone of rays, then points *e* and *i* would be invisible. But suppose a point *assumed* at I and the angles *c* and *d* constructed there, then the vanishing points would fall much nearer on both sides to C, and the length of the sides of the angle constructed at I being much shorter than the line V P, the measuring points would be much nearer to their vanishing points. The student is particularly requested to make a drawing of this object of the same dimensions as are here given, *assuming* the point I instead of P, and to compare the two drawings, asking himself which *appears* the truest; he will probably arrive at the conviction that the ASSUMPTION of the point I is an act of PRESUMPTION. The angle employed, if I is assumed, is one of 90 degrees.

It is more desirable to impress this upon the attention here, as we shall probably no longer be able to represent the whole of the base of the cone of rays, *but the student will understand that* IN EVERY EXAMPLE THE TRUE LENGTH OF THE PRINCIPAL VISUAL RAY OF A CONE OF 60 DEGREES HAS BEEN OBTAINED AND IS EMPLOYED.

It may be well to notice that in all the figures the *visible* portions of the objects will be represented by the *strongest lines*, the *invisible* portions by *lighter lines*, and the *working* lines, that is those employed to produce the object, but forming no part of it, will be *dotted lines*.

Plate .VIII



LESSON VIII.

PLATE 9, FIG. 27.

To put into perspective a rectangular table 5 feet in length, 3 feet wide, the top of the table being 2 feet 10½ inches from the ground plane on which it stands, its sides making angles with the picture plane equal to angles *a* and *b*, and *one of its angles* touching the picture plane.

The plan of the table is given at I, where *s* and *t* are two edges of the top, *u v x y* the leg, *z z* the rails joining the legs and supporting the top.

A portion of the elevation is *given at* L, where *u* is the leg and *z* the rail.

The diameter of the base of the cone of rays, C its centre, and C P the principal visual ray, are shown. At P construct angles equal to angles *a* and *b*, and find vanishing points 1 and 2, and measuring points 1 and 2, as in the last lesson.

Draw the picture or ground line G, making its distance below the horizontal line to represent one foot, divide a vertical line between the ground line and the horizontal into a scale of inches as at 3, 6 and 12.

Let us assume a point *o* on the ground line, to represent the seat of that angle of the table touching the picture plane.

Draw lines from *o* to V 1 and V 2.

Set off to the left of *o* 5 feet, and to the right 3 feet on the produced picture line, as at 5 and 3.

Draw lines from 5 to M 1 and from 3 to M 2, cutting lines *o*, V 1 and *o*, V 2 in *e* and *f*.

Complete the oblong by drawing lines from *e* to V 2, and from *f* to V 1, this oblong will be equal to the top of the table.

By the scale, the legs will be found to be 3 inches within the edges of the table, and 3 inches square, as shown at I.

To obtain the seats of the legs, set off from *o*, 5 and 3, on the picture line 3 inches, as at 3′, 3′, 3′, 3′, and a second 3 inches as at 3″, 3″, 3″, 3″.

From the threes to the left of *o* draw lines to M 1, to cut line *o*, V 1.

From the threes to the right of *o* draw lines to M 2, to cut line *o*, V 2.

From the points on *o*, V 1 so obtained, draw lines to the vanishing point V 2, and from the points on *o*, V 2 draw lines to V 1. The intersections of those lines will give four small squares, which squares are the seats of the legs of the table.

At *o* erect a perpendicular 2 feet 10½ inches by scale, as at *o g*, set off from the upper extremity of this line 1½ inches for the thickness of the top of the table, as at *h*.

Draw lines from g and *h* to V 1 and V 2, cut them by perpendiculars from *e* and *f* to determine the sides of the table top.

At *h* draw a horizontal line as *i i*.

From *h* set off to the left 3 inches, as at 3‴. Draw a line from 3‴ to M 1, cutting the edge of the table in *l*.

Draw a line from *l* to V 2.

Erect a perpendicular from the front angle of the table leg nearest *o* on the ground plane, to cut line *l*, V 2 in *n*.

Erect a perpendicular from the external angle of the leg to the right, to cut line *l*, V 2 in *p*.

Draw a line from *n* to V 1, cutting it by a perpendicular from the external angle of the leg to the left, in *q*.

Erect perpendiculars from the angles correspondent to angles *x* of the legs on the plane *o*, V 1, to cut line *n q*, and from the angles correspondent to angles *u* of the legs on the plane *o*, V 2, in fact transfer the small squares on the ground

plane to the *under side* of the top of the table, and join them by perpendiculars.

The rails now only remain to be added.

The rails are 4 inches from the edges of the table, therefore from *h* on the line *i i*, set off 4 inches, as at 4.

From 4 draw a line to M 2, cutting the lower edge of the table top.

Drop a perpendicular from 4 equal to the depth of the rail *z*, drop also a perpendicular from the obtained point on the lower edge of the table top, draw a line from the lower extremity of the perpendicular from 4 to M 2, to cut the corresponding perpendicular from the edge of the table, and from the two extremities of this last obtained perpendicular, draw lines to V 1, the upper one to cut the top of the leg to the left, and the lower one to cut a perpendicular from this last point of intersection.

For the under edge of this rail, draw a line from the last obtained angle to V 2, to cut the vertical edge of the leg, and through this point draw a line from V 1 to the front leg.

The process only requires to be repeated 4 inches to the left of *n* for side *n*, *p*, and can require no further explanation.

There only remains one point to explain, the obtaining the thickness of the under edge of the rail, as visible on the two distant sides of the table.

Draw the square of the leg, as at 8, or as shown at large at M, draw the diagonal 8, 9. Produce the edge of the rail to cut this diagonal, as at 7, and from 7 draw a line to V 1.

Repeat the process on the distant front leg for the remaining side.

The student will do well to direct his attention to the manner in which the rails of the table are obtained, as the process, although simple, is confusing, unless thoroughly understood ; it is, besides, one often required in practice. He will observe, that the line *i i*, drawn through *h*, is on the plane of the picture, the perpendicular from 4 is therefore on the picture plane—by drawing a line from 4 to M 2, to cut the

edge of the table *h*, V 2, we obtain a distance of 4 inches from the edge *h*, V 1; the line drawn from this point to V 1 is therefore a line on the under side of the table, this line being the upper edge of the rail. We drop a perpendicular from 4, which, being on the picture plane, is made geometrically equal to the depth of the rail, that is, 6 inches. We also drop a perpendicular from the edge of the table, at the point where the line drawn from 4, to M 2, cuts it, and by drawing a line from the lower extremity of the perpendicular on the picture plane also to M 2, we transfer this vertical height on the picture plane to a *vertical* line from the edge of the table which is within the picture; but one extremity of this vertical line represents the upper edge of the rail, and the rail is a vertical plane; therefore, the lower extremity of this vertical line will furnish us with a point from which to draw the line for the lower edge of the rail.

LESSON IX.

We have hitherto found all the vanishing points and measuring points we have required, upon the horizontal line; the planes we have employed having been either horizontal or vertical planes; but we have used the term *Oblique Planes*, it is to oblique planes that we now proceed.

In fig. 28, plate 10 we have a book, A, standing on its edge, and perpendicular to the picture plane, its side, A, is a vertical plane, having its vanishing point in the centre of vision.—Book B lies upon the ground plane, with its back parallel to the picture plane; its side B is, therefore, a horizontal plane, having its vanishing point also in the centre of vision.—Book C lies upon the ground plane, its cover C is, therefore, a horizontal plane, but its edges are neither parallel nor perpendicular to the picture plane; therefore, it will not have a vanishing point in the centre of vision, but still being a horizontal plane, its vanishing point will lie upon the horizontal line.—Book D stands on its edge on the ground plane, its covers are vertical planes, but they are not perpendicular to the picture plane; therefore, their vanishing points will not lie in the centre of vision; but, being vertical planes, *that is, perpendicular to the ground plane*, they will have their vanishing points in the horizontal line. Let us observe, then, that although the *edges* of the books C and D make oblique angles with the picture plane, yet, as they *do not make oblique angles with the ground plane*, they are not called *oblique*, but horizontal or vertical planes.—Books E and F are neither horizontal nor vertical in their position, yet their sides are only oblique to

picture plane B, B, and the horizontal line H will be *equal*, as they are represented isometrically.

If the student will refer to fig. 25, he will remember that the vanishing point of the line 5, 6, was obtained by drawing a line from C, which, in that case, represented the position of the eye, parallel to line 5, 6, until it cut the base line in *u*, this line was spoken of as representing the edge of a *vanishing plane.*

Now let us construct at S, fig. 30, two planes parallel to the covers of the book, assuming S A as their vertical height, and extending from S A to the picture plane ; that is, draw a line from S parallel to the lower edges of the book, cutting the picture plane in B, B.—From A draw lines parallel to the upper edges of the book ; from B, B, erect perpendiculars to cut the lines drawn from A in C, C.

We have now obtained *two planes which are parallel* to the covers of the book, the planes S, A, C, B ; those planes are the VANISHING PLANES *of the covers*, one of their *vertical edges* being coincident with the position of the spectator, the other with the picture plane.—If we draw *lines* from P, the position of the eye, parallel to the edges S, B, we shall find that such lines will cut the vertical edge B, C, of the vanishing plane at the point where such edge coincides with, or cuts, the horizontal line on the picture plane.—In other words, that a line drawn from P, parallel to S, B, and therefore parallel to the upper and lower edges of the book, cuts the horizontal line in a point which will be the *vanishing* POINT of the book cover; and that this vanishing POINT lies upon the *edge of the vanishing* PLANE, *which coincides with the picture plane.*

The points V and V are then the vanishing points of the upper and lower edges of the book. Now all vanishing points must be found upon the picture plane, but all such *points* are merely the extremities of *lines*, which lines lie upon vanishing planes, therefore *all vanishing points will lie upon the* LINE *where the vanishing* PLANE *cuts the picture* PLANE.

The book, fig. 30, is represented isometrically; it will be observed that the top and bottom edges, 1, 1, and 2, 2, are parallel to each other, and of equal length, while the vertical edges, 1, 1, and 2, 2, are equal in length to the back of the book, which is seen to be nearer to the spectator; the lines forming the sides of the book may therefore be supposed to have their *geometrical lengths;* but if, as intended, the book have, as in ordinary cases, rectangular sides, then it will be evident that the upper and lower edges 1, 1, and 2, 2, and the vertical edges, 1, 1, and 2, 2, do not occupy their geometrical relation to each other, as the angles at 1, 1, and 2, 2, are not right angles. But although the upper and lower edges do not occupy their true relation to each other, yet the two planes or covers of the book, 1, 1, and 2, 2, do make with each other the true *geometrical angle* at which they are supposed to be open. On the cover, 1, 1, of the book, certain lines are drawn, which make oblique angles with the lower edge 1, as lines *a*, *b*, and *c;* lines *a* and *b* are parallel to each other, and line *c* has also a parallel drawn from 1.

The book, then, is isometrically represented—it may be supposed to stand upon any plane as a table. Let *p*, *p*, *p*, *p*, represent the picture plane standing vertically on its edge—H is the horizontal line drawn upon the picture plane—G represents the table or ground plane; it must be remembered, that as the book is represented isometrically, so is the ground plane and the picture plane.

Now let us assume the spectator to be standing on the ground plane at S, and the position of his eye to be at P—the distance S P, and the space between the lower edge of the

shown than could be seen at once; it is therefore sometimes called Isometrical Perspective, but this is an improper term. *Isometrical Drawing* may often be of great use; but the term *Isometrical Perspective* is an absurd misnomer.

Isometry violates every truth of Geometry in the *relation which it makes the lines of objects bear to each other,* every law of Perspective in the *dimensions and appearances of objects;* it is nevertheless of frequent practical utility.

perspective drawing as in fig. 31, plate 11. Book E is the perspective representative of the book in fig. 30 ; it has the same lines *a*, *b*, and *c* upon its side—the same vanishing points for its upper and lower edges in V, V.—through V a vertical line is drawn, and upon it the *accidental vanishing points* V 2 and V 3 are set up.—the lines *a*, *b*, and *c* are set off on the near edge of the cover, and those lines are drawn to their respective vanishing points.

In book F, fig. 31, we have one lying on the ground plane, the edges of its sides making similar angles, with the picture plane, to book E ; it has therefore the same vanishing *planes*. The cover lying on the ground plane will converge to V, V, on the horizontal line ; but the raised cover F is parallel to lines *a* and *b* on book E, therefore cover F will converge towards V 2 ; that is, V 2 will be the accidental vanishing point of cover F ; but only two edges of cover F converge to V 2, edges 2, 3, and 2, 3, are parallel to the edges of the cover lying on the ground plane, therefore lines 2, 3 and 2, 3, will converge to, or have their vanishing point in, V on the horizontal line.

It is evident then, that, for *oblique planes* a *vertical line* is employed on which to find their *accidental vanishing points instead of* the horizontal line ; upon examination we shall find that this vertical line may be employed in every respect for oblique planes as the horizontal line is employed for horizontal planes ; that is, upon it we may obtain not only *vanishing*, but

MEASURING POINTS.

Let us prepare fig. 32, where we have a book, one of its covers lying on the ground plane, its sides having points V 1 and V 2 obtained as in figs. 26 and 27. If we revert to fig. 30, we find that, in order to find the accidental points V 2 and V 3, we drew lines from P parallel to the lines on the cover ; that is, we drew lines from P, making, with line P V, angles equal to the angles made by the lines *a*, *b*, and *c* with the upper and lower edges of the book. In other words, we constructed, at one extremity of the vanishing line V P, an

Plate.X

Fig.XXVIII

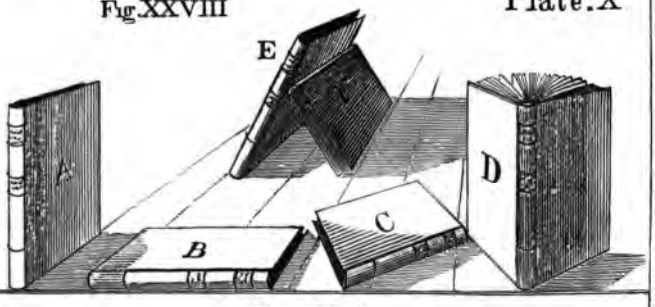


Fig.XXIX

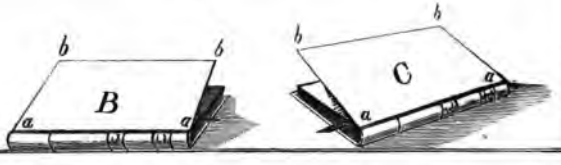
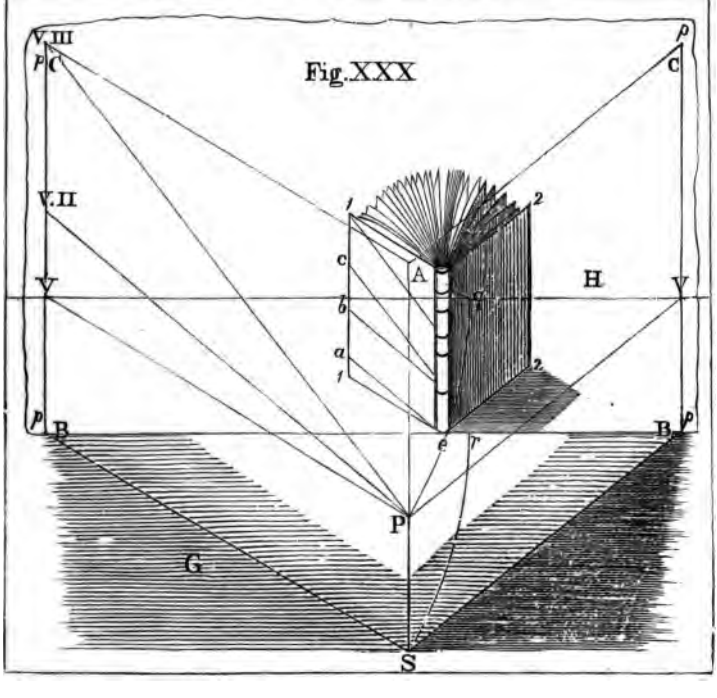


Fig.XXX



angle equal to the angle made by the oblique line with the ground plane.

Now let us suppose that the plane S A C B, fig. 30, on which all these lines are drawn, could be moved, or shut, upon the picture plane like a book cover, making line C B the hinge, then it would follow that, line B S would coincide with line B *r*—line V P with V *q*, and the vanishing line P, V 3 with line *q*, V 3.*

But line V P is the vanishing line, in other words it is equal to the distance of the vanishing point V from the place of the eye, and V *q* being equal to V P is therefore equal to the distance of the eye from the vanishing point. But in figs. 25, 26 and 27, we have employed similar means to obtain the measuring point of a vanishing point; thus in fig. 25 from V as centre, with V P as radius, we described an arc cutting the horizontal line in M. The point *q*, fig. 30, is therefore the measuring point of vanishing point V. But it is at *q* that the angle V, *q*, V 3, is now found; the other extremity of the side of which, *q*, V 3, is the accidental vanishing point.

THEREFORE, TO FIND AN ACCIDENTAL VANISHING POINT, CONSTRUCT UPON THE HORIZONTAL LINE, AT THE MEASURING POINT OF THE VANISHING POINT OF THE PLANE TO WHICH IT BELONGS † AN ANGLE EQUAL TO THE ANGLE MADE

* The student must not be puzzled by the fact, that in the Isometrical Drawing the lines B S, and V P, *measure* the same as line V *q*; and that the line P, V 3 does *not measure* the same as the line *q*, V 3, he must remember that the *necessities of Isometrical Drawing* have converted the *rectangular* book cover into a rhomboid, and the *really* rectangular vanishing plane into a rhomboid also, by which cause while the *sides* of the rhomboid are of the same length as the *sides* of the rectangle, the *diagonals* of the rhomboid alter in their lengths, as compared with the *diagonals* of the rectangle, one of the rhomboid's diagonals being longer and one shorter than the diagonals of the rectangle. Line *q*, V 3, is therefore the *true diagonal* of the rectangular vanishing plane, of which P A C V is an Isometrical representation.

† This vanishing point is for distinction, when accidental vanishing points are used, called the *original* vanishing point.

BY THE OBLIQUE PLANE WITH THE GROUND PLANE, PRODUCING ITS SIDE TO CUT A PERPENDICULAR DRAWN THROUGH THE ORIGINAL VANISHING POINT.

Let us then revert to fig. 32. Upon the horizontal line we have set off the measuring point of vanishing point 1 at M 1, and we have drawn a vertical line through V 1.

Then at M 1, on the line M, V 1, construct an angle equal to angle V 3, P, V fig. 30, and produce its side to cut the vertical line in V 3, this point will be the accidental vanishing point required. From the angles of the back of the book therefore, draw lines to V 3 for the opened cover.

We have said before that the vertical line through the original vanishing point would fulfil the same purpose for the obtainment of *measuring points* for oblique planes that the horizontal line performed for horizontal planes. Let us examine this.

We obtain the measuring point M 1 by setting off from V 1 the length of the vanishing line V 1, P as shown in figs. 25, 26, 27 and 32. The measuring point and the vanishing point of a line, always lying upon the same line whether it be *vertical or horizontal*; therefore, *if from* V 3 *we set off on the vertical line* V 3 the length of the vanishing line V 3, M 1, as at M 3, we obtain the measuring point of vanishing point V 3.

The measuring point M 1 lies upon the horizontal line, therefore all lines to be measured by it must lie on horizontal planes in order that the geometric dimensions of such lines *may be set off on lines drawn* HORIZONTALLY *on the picture plane.* The measuring point M 3 lies upon a vertical line, therefore all lines to be measured by it must lie on vertical planes in order that the geometric dimensions of such lines *may be set off on lines drawn* VERTICALLY *on the picture plane.*

In order to determine the width of the oblique plane F, fig. 32, making it equal to the cover lying on the ground plane, we must first obtain the geometric width of this plane. Therefore draw a line from M 1 through angle 1, producing

Plate. XI.

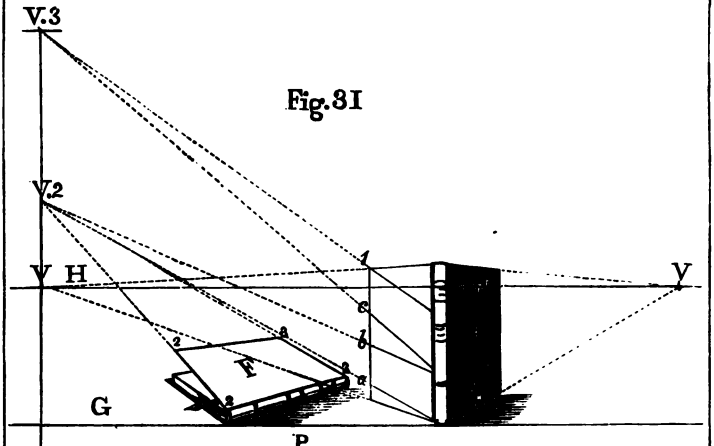


Fig. 31

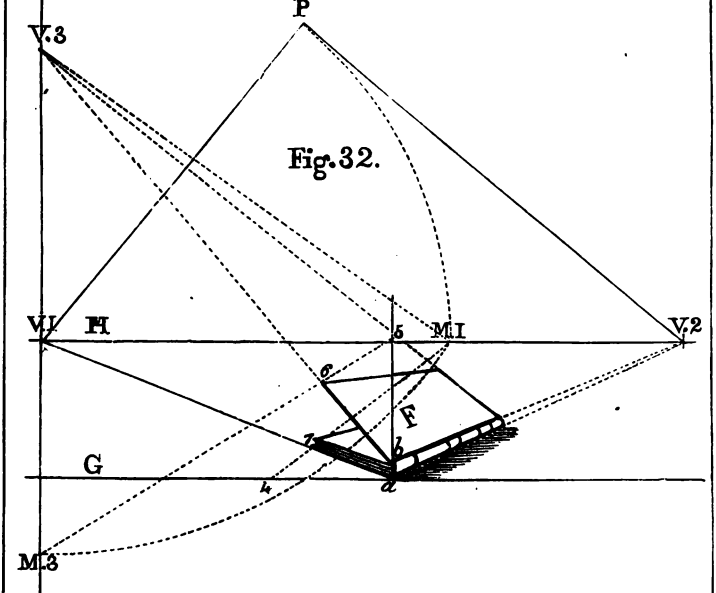


Fig. 32.

it to cut the picture line in 4, the line 4 *a* will be the geometric length required. Set up from the angle *b* of the cover F, which touches the picture plane, a vertical line, as line *b*; from *b* set up *a* 4 as at *b* 5; draw a line from 5 to M 3, it will cut line *b*, V 3 in 6; from 6 draw a line to V 2, it will complete the cover.

In thus employing the vertical line through V 1 for the finding V 3 and M 3, as we employ the horizontal line for finding V 2 and M 2, it will be seen that we substitute M 1 for P. Thus if V 1 were given as one vanishing point of a rectangle, we should only require to draw line V 1 P, and by drawing at P, another line perpendicular to it to cut the horizontal line in V 2, we should obtain the other vanishing point of the rectangle; so, if on the plane F we wish to construct a rectangular body, that is to draw lines from *b* and 6, which would be perpendicular to *b* 6, we have only to draw at M 1 a line perpendicular to M 1, V 3, and produce it to cut the vertical line V 3, in order to find the accidental vanishing point of such lines; but this we propose to exemplify in the next lesson.

LESSON X.

PLATE 12, FIG. 33.

To put into perspective a box 6 feet long, 3 feet wide, 1 foot 6 inches high; its sides making given angles with the picture plane, and having a lid opened at a given angle with the picture plane; the depth of the lid being 9 inches, the thickness of the box and the lid to be 3 inches as figured in the section at A.

The base of the cone of rays is described, the principal visual ray set up from its centre, and at its extremity P, an angle is constructed, giving the vanishing points of the box V 1 and V 2; the measuring points of the box are also found at M 1 and M 2.

A vertical line is set up on the ground line at G—the space between G and the horizontal line is divided into five equal parts, each representing 6 inches, the scale is figured 3, 6 for inches, 1 and 2 for feet.

The box is placed in perspective, one of its angles touching the picture plane at *a* in the same manner in which the table fig. 27 was drawn; we can have no need therefore to repeat the directions, the lines are however left in the drawing.

We shall suppose the student to have completed the box, top edges and all, and commence the drawing of the lid.

It is proposed to make the lid to open on the line *o' c*, it must then open in the direction of V 1, *therefore* V 1 *will be its original vanishing point:* then, as shown in fig. 32, the given angle at which it is to be opened must be constructed at M 1.

In the section at A the angle *b b z* is the given angle. Therefore at M 1 construct an angle equal to angle *b b z*, as angle *x* M 1 *x*, and produce its side to cut a perpendicular through V 1 in A, V 1.* From A, V 1 as centre with line A V 1, M 1 as radius, describe an arc cutting the perpendicular in A M 1. A V 1 is the vanishing point of the plane of the lid represented by line *b b* in the section, and A M 1 is the measuring point of that vanishing point.

Let us commence then by drawing lines from *o'* and *c* to A V 1.

From these lines we require to cut off 3 feet by means of A M 1.

Erect a perpendicular at *o*, making *o* 3 equal 3 feet by scale.

Erect a perpendicular also at *o'*, produce it indefinitely.

Draw line 3, V 1, cutting the perpendicular from *o'* in 3'.

From 3' draw a line to A M 1, cutting the line *o'*, A V 1 in 3''.

Draw a line from 3'' to V 2, cutting line *c*, A V 1 in *d*, and the bounding lines of this plane of the lid are completed.

Now let us observe that in order to obtain the length of the line *o'* 3'', we first set up on the *picture plane at o* a perpendicular equal to 3 feet. At the other extremity *o'* of the side of the box, we set up a second perpendicular, the two extremities of *o* and *o'* are joined by a vanishing line *o*, *o'*, V 1 ; therefore, if we draw a line from 3 to V 1 cutting perpendicular *o'* in 3', we transfer the geometric 3 feet at *o* 3 on the picture plane to a line within the picture ; but one extremity of the *vertical* line *o'* 3' is coincident with the line which we require to measure ; therefore, as *o'* 3' is the perspective representative of the vertical line on the picture plane, by drawing a line from 3' to

* The line *b z*, making with line *b b* the given angle, is a vertical line, therefore, when we require to construct a similar angle at M 1, we draw a vertical line as M 1 *x*, and draw another line, making with the vertical line an angle equal to the angle *z*, *b*, *b*,—the angle V 1, M 1, A, V 1, being equal to the angle which the box-lid makes with the ground plane.

A M 1, cutting line *o'*, A V 1 in 3″, we determine its length, as precisely as we shall do if we find on the picture plane a point from which to set up 3 feet to draw directly back to A M 1. Let us illustrate this: the vertical line from *o* on the picture plane must be produced. Now from A M 1 draw a line through *o'*, and produce it to cut the vertical line *o*, as in *w*, from *w* set up 3 feet as at *y*; draw a line from *y* to A M 1, it will cut line *o'* 3″ in 3″, that is, the result will be the same.

Let us recur to the plane of the lid *o'*, 3″, *d*, *c*; we require upon it the lines which indicate its thickness.

The lines which give the thickness of the two ends of the box are produced to cut the edge of the lid *o'*, *c*; therefore, from those points draw lines to A V 1, they will give the thickness of the ends of the lid.

We now require the thickness of the front and back edges.

We must obtain this thickness on the line *o'* 3″; therefore, as for that line, set off from *o* and 3 the geometric thickness, 3 inches, as at 2 and 2. Draw lines from 2 and 2 to V 1 cutting line *o'*, 3′ in 2′ and 2′. From 2′ and 2′ draw lines to A M 1 cutting line *o'* 3″ in 2″ and 2″. Draw lines from 2″ and 2″ to V 2 to complete the edge of the lid.

The front and back of the lid are perpendicular to the plane *b b* as shown in the section, as lines *b v*; therefore to find the accidental vanishing point of the lines *b v*, at M 1 on the horizontal line, draw a line perpendicular to line A V 1, M 1 to cut the vertical line through V 1 in A V 2. A V 2 is the vanishing point required.

From A V 2, as centre with line A V 2, M 1 as radius, describe an arc cutting the vertical line in A M 2. A M 2 is the measuring point of A V 2.

To complete the lid, therefore, draw lines from 0′ and 3″ to A V 2.

To determine their length, given in the section as 9 in., set down from 0 the front edge of the box on the picture plane, 9 in. as at 9.

Draw a line from 9 to V 1, cutting the vertical edge 0′ in 9′.

Draw a line from 9′ to A M 2, cutting line 0′, A V 2 in 9″.

Draw a line from 9″ to A V 1, cutting line 3″ A V 2; this will complete this end of the lid.

Draw a line 9″ in the direction V 2 for the small visible portion of the back edge of the lid.

We have now the *inside* of the lid to complete, its only visible angle is at 0″; let us draw line 0‴ A V 2. We require to cut this line at 6 inches from 0″.

Let us set up from 9 on the front edge, 0 *a*, of the box 3 in. as at 3‴.

Draw a line from 3‴ to V 1, cutting the distant edge of the box in 0″.

From 0″ draw a line to A M 2, cutting the edge of the lid in 6.″

Draw a line from 6″ to A V 1, it will represent the thickness of the lid.

Draw a line from 2″ to A V 2 cutting the last line in 6‴.

Draw a line from 6‴ to V 2′, it will cut the line from 0‴ to A V 2 in 6⁗.

Draw a line from A V 1 through 6⁗ to complete the visible portions of the edges of the lid.

LESSON XI.

PLATE 13, FIG. 34.

WE propose to practise still further the use of vanishing points lying off the horizontal line, but will first construct a box making similar angles with the plane of the picture as in the last figure. The front of the box being 2 feet 6 inches in length, its end 2 feet, and its height 1 foot 3 inches. The front angle of the box to be 1 foot to the left of the central vertical line, and 1 foot 3 inches within the picture as at *a*.

The student cannot, it is hoped, need any instruction to enable him to complete the box. The base of the cone of rays, the principal visual ray, the angle constructed at P, and the vanishing and measuring points are found all as in the last figure. The vertical line lying between the picture and horizontal lines, is not, however, divided as in the last figure, it now representing a scale of 1 foot, and being divided into 3 and 6 inches, as at 3′ and 6′. It will be found desirable to set off on the horizontal line at least one point of distance as at D.

The seat of the front angle, of the box, as *a*, will be found by the use of the centre of vision, and the point of distance as shown in fig. 22, as also the height of the box at *a*.

From *a* lines being drawn to the two vanishing points, their length is determined by drawing, for the front, a line from M 2 to cut the picture line as in 0, the geometric length 2·6 being set off from this point as at 2·6, and a line drawn from it back to M 2 cutting off the required length from the line *a*, V 2. The depth of the box is obtained in a similar manner.

AV I

Supposing then the box to be completed, let us proceed to construct a chair, its sides making angles with the plane of the picture, similar to those of the box.

It is proposed to place the first back leg of the chair 1 foot 3 inches within the picture; and coincident with the central vertical line as at *b*, and to incline it backwards on the edge of the box.

The vanishing points of the box will be the *original* vanishing points of the chair, and its inclined planes will have their accidental vanishing points in a vertical line drawn through one or other of the original vanishing points, as in the lid of the box in the last figure.

Draw, therefore, a vertical line through V 1 as in the last figure.

The seat of the leg *b* will be found as the seat of angle *a* was found, or, as the distance is the same, a horizontal line drawn from *a* to cut the central vertical line will give the required point.

To find the point of contact of the back of the chair with the edge of the box, draw a line from *b* to V 1, cutting *lower* edge of box in *c*.

From *c* draw a vertical line, cutting the *upper* edge of box in *d*; *d* will be the point of contact.

Draw line *b d* and produce it to cut the vertical line through *b* 1 as in A V 1,* which will be the vanishing point of the inclined plane of the back of the chair.

We have found the accidental vanishing point then, not as in the last case by constructing an angle at the measuring point, but by drawing a line through two obtained points *b* and *d*. We shall require a vanishing point for planes at right angles to the back of the chair, therefore draw line A V 1, M 1, and upon this line at M 1 construct a right angle producing its side to cut the vertical line V 1 in A V 2, and find the measuring points of A V 1 and A V 2 as in the last figure.

Let us proceed to construct the block or skeleton of the

* A V 1 lies beyond the limit of the plate.

chair of the following dimensions, 1 foot 6 inches square in plan, 1 foot 6 inches from ground to top of seat, 3 feet 6 inches to top of back.

We shall require to transfer those dimensions to the vertical line *b* which is 1 foot 3 inches within the picture, and parallel to the picture plane; therefore draw a line from V 1 through *b* and produce it to cut the picture line in *e*. At *e* erect a vertical line, it will lie upon the plane of the picture, and any geometric dimensions may be set off upon it, as 1·6 and 3·6.

From 1·6 and 3·6 draw lines to V 1, cutting the vertical line *b* in 1·6′ and 3·6′, and the geometric heights of 1 foot 6 inches and 3 feet 6 inches will be transferred 1 foot 3 inches within the picture.

From 1·6′ and 3·6′ draw lines to A M 1, cutting line *b*, A V 1 in 1·6″ and 3·6″.*

From *b* draw a line to V 2, determine its length as given, 1 foot 6 inches as in the box; that is, draw a line from M 2 through *b*, producing it to cut the picture line in 0. From 0 set off over the picture line 1 foot six inches as at 2·6. Draw line 2·6, M 2 cutting line *b* V 2 in *f*.

Draw line *f*, A V 1 and line 3·6″, V 2 cutting each other in *g*, and the back of the chair will be obtained.

From A V 2 draw a line through *b* and produce it.

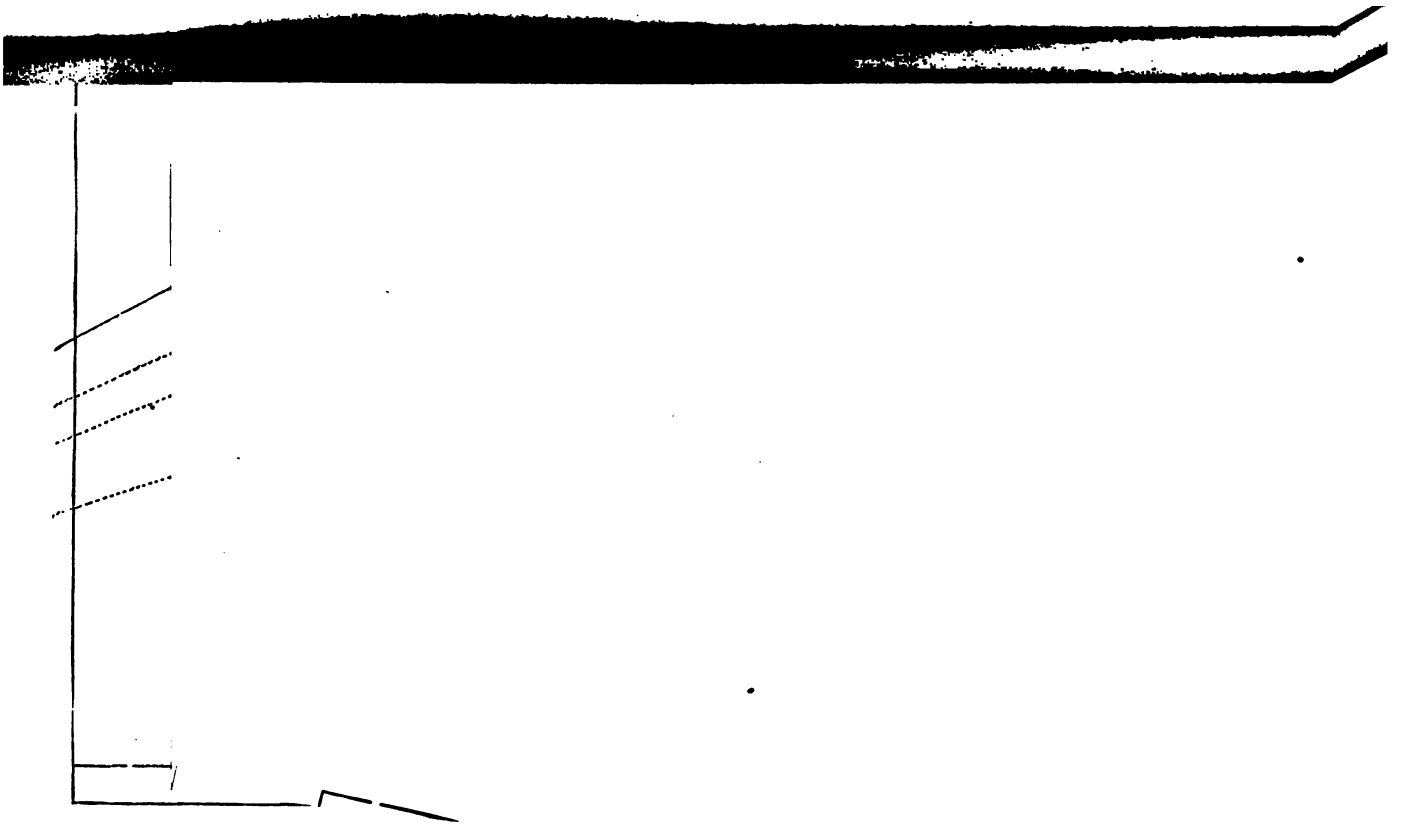
From A M 2 draw a line through 1·6′ and produce it to cut the line last drawn in *h*.

From A V 2 draw a line through *f*, and from *h* a line to V 2, cutting each other in *k*.

From A V 2 draw a line through 1·6″, and from *h* a line to A V 1, cutting each other in *i*.

Draw lines *i*, V 2 and *k*, A V 1 cutting each other in *l*.

* It was not absolutely necessary to draw the line from V 1 through *b* to cut the picture line in *e*, in order to set up a line of heights, because we know that the portion of the vertical line *b* lying between *b* and the horizontal line, as *b* C is equal to 1 foot; we might therefore divide this line *b c* into a scale precisely as we divided the original vertical line lying between the picture and the horizontal lines.



Draw line *l*, A V 2 cutting line *f*, *g* in *m* and join *m*, 1·6″ and the skeleton of the chair is completed.

For the completion of the chair, as shown in fig. 35, Plate 14, only a *repetition* of the process the student has already performed has to be passed through ; it consists indeed but in the application to inclined or oblique planes of the method by which the table, fig. 27, Plate 9, was put into perspective ; we will, however, describe the process in detail, commencing at the completion of fig. 34 ; and we proceed to give the dimensions of the details of the chair, its legs being 2 inches square, the seat 1 inch in thickness, the rails being all 2 inches wide and 1 inch thick.

Upon the angles of the square plane *b*, *f*, *h*, *k*, let us construct four other squares 2 inches in diameter, for the plan of the legs ; that is, let us cut off from *b* and *h* on the line *b h*, 2 inches, and from *b* and *f* on the line *b f*, 2 inches, by a similar process to that by which we obtained the length of the whole lines *b h* and *b f*. Therefore from 0 and 2·6, on the picture line set off 2 inches as at 2′, 2′. Draw lines 2′, 2′, M 2 cutting line *b f*. From *e* on the picture line set up 2 inches on the vertical line as at 2′. Draw line 2′, V 1, cutting the vertical line *b* ; from 1·6 set down on the vertical line *e* a distance equal to 1 inch, 2 inches, and 3 inches, as at 1′, 2′, and 3′, draw lines from those points to V 1 cutting the vertical line *b*.

From A M 2 draw lines through the points obtained from both the points marked 2′ in the vertical line *e*, cutting line *b h*. From the two points thus obtained on *b h*, draw lines to V 2. From A V 2 draw lines through the two similar obtained points on *b f*, and the four squares for the legs are obtained. Draw lines from the angles of those squares to A V 1 for all the visible sides.

For the seat of the chair, 1 inch in thickness ; bisect 1·6, 2′ on the vertical line *e* as at 1′. Draw line 1′, V 1, to cut the vertical line *b* ; from the point obtained draw a line to A M 1 cutting the back edge of the back of the chair. Draw a line from A V 2 through this point, and complete the seat of the chair.

To obtain the rails of the chair, which are each 2 inches wide and 1 inch thick, and which are level, or flush, with the face of the legs.—Draw lines in the centre of the visible sides of each leg by repeating the process by which the four small squares were obtained, and draw the central lines on each visible face of the legs as in the figure.

The rail immediately under the seat is set off on the vertical line *e* as at 1′ 3′, the measurements carried back to the vertical line *b*, and then by A M 1 transferred to the back of the chair, reference to the figure will, it is believed, render unnecessary any further description.

LESSON XII.

PLATE 15, FIG. 36.

IT is proposed to construct a flight of five steps ascending into the picture, each step to be 6 inches high and 1 foot broad, or as it is technically termed, 6 inches rise and 1 foot tread or going, and 3 feet in width.

We will proceed to construct the steps, first by the use of the centre of vision and the point of distance: C is assumed, D obtained and the ground line drawn, the space between the ground line and the horizontal line being made a scale of 3 feet at *z*.

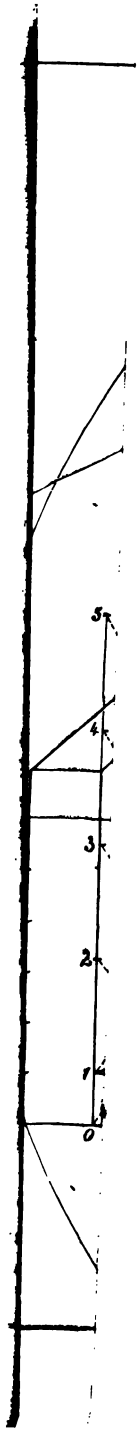
Let us place 0, one extremity of the first step, touching the picture line, 9 inches to the right of *z* and set off from 0, 3 feet as at 3.

At 3 let us construct a vertical plane equal to the height of the 5 steps, that is 2 feet 6 inches; and equal also to the depth of the 5 steps, that is 5 feet.

The vertical plane 3, 2·6, 5, has those dimensions, its front edge is divided geometrically into five parts of 6 inches each for the rise of the steps, and its lower edge 3, 5 is divided by means of the point of distance into five parts of 1 foot each for the tread of the steps.

By drawing lines from the divisions on the edge 3, 2·6 to C, and erecting perpendiculars from the divisions on the edge 3, 5, we shall obtain the outline of the steps on the vertical plane 3, 2·6, 5, 5. If we construct a similar vertical plane at 0, and obtain upon it a similar outline, we shall only require to join the respective angles in order to form the edges of the steps

represented, it can only be placed in Perspective by means of *intersecting straight lines, giving points of intersection*, through which the curved line must pass, the curved line itself being drawn by the hand, or, technically speaking, *free-handedly*. It follows then, that if in any curved line, regular or irregular, a series of points be assumed, and straight lines drawn through such points intersecting each other, that by placing such intersecting lines in Perspective we obtain a series of correspondent points through which we may draw a correspondent curved line; and, as we may multiply the points of intersection to any extent, and draw straight lines upon any plane, whether horizontal, vertical, or oblique, it follows that we can represent curved lines of any variety upon any plane. We proceed to exemplify this in the next Plate.


5
4
3
2
1
0

LESSON XIII.

PLATE 16, FIG. 37.

LET A, B, D and E represent respectively horizontal, inclined, vertical, and oblique planes, each plane being square, and the front edge of the first three touching the plane of the picture; upon each plane it is proposed to inscribe a circle. No direction can be necessary for the construction of the square planes, we shall therefore suppose them drawn, and the student to have the necessary vanishing and measuring points.

Construct a square in plan having sides equal to the perspective square A, as F, and inscribe a circle.

Draw the two diagonals of the square, and two diameters of the circle parallel to the sides of the square.

The two diagonals of the square intersect the periphery of the circle at 2, 4, 6, and 8, and the two diameters at 1, 3, 5 and 7.

Let us now draw on each of the four planes A, B, D and E their diagonals, and we have the perspective representatives on each plane of the lines 2, 6 and 8, 4 in the plane F. But the intersection of the diagonals gives the point through which to draw the diameters, which may be next drawn to their respective vanishing points and numbered at their extremities as in the plan 1, 3, 5, 7.—Now it will be observed that we have in perspective *four* points of intersection on each plane, that is where the four diameters cut the sides of the squares, because the circle passes through these points; but the diagonals

have not yet furnished us with any points of intersection. Let us, however, draw lines through the points where the diagonals intersect the circle in plan, as lines 2, 4 and 6, 8, and we have two other lines which may also be placed in Perspective on the planes A, B, D, E, and which will furnish us with the points required.

All that remains must be done by the free-hand; and in drawing a curved line passing through the points 1, 2, 3, 4, 5, 6, 7, 8, great pains must be taken to preserve a continuous curvature, and the student will do well to bear in mind the following facts.

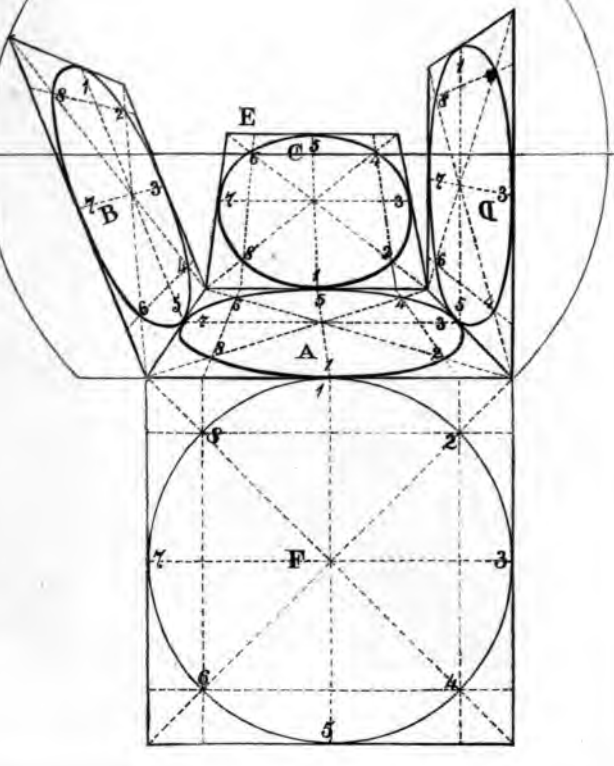
1. That, a circle seen in Perspective is *not* an ellipse—the two segments 3, 1, 7 and 3, 5, 7 on planes A and C, and 1, 3, 5 and 1, 7, 5 on planes B and D, are evidently very unequal; and although, if the eye be immediately opposite the centre of the circle, the segments 3, 1 and 1, 7 on planes A and C will be equal, yet the segments 3, 1, 7 and 3, 5, 7 on those planes must always remain unequal, from the fact that the segment 3, 1, 7 is nearer to the eye than 3, 5, 7.

2. That, in a circle on the ground plane, the curve undergoes the most rapid change in the segments 8, 7, 6 and 2, 3, 4 and that the arcs 7, 8 and 3, 2 are the fullest, or quickest, in the whole curve.—It is a common mistake to spoil the curve, by making this portion too flat, giving the appearance rather of two arcs *intersecting* at 3 and 7, than of a continuous curve.

In these examples eight points only have been employed, the student may use as many more as he may choose, indeed it will be well that he should draw some circles much larger and employ a greater number of points between the lines 3, and 2, 4 and 7 and 8, 6. It may also be mentioned that it is not *necessary* to place a whole circle in plan, the semicircle with its enclosing oblong answering the same purpose.

Plate. XVI.

Fig. 37.



LESSON XIV.

PLATE 17, FIG. 38.

IN this figure the same vanishing points and measuring points have been employed as in fig. 33, plate 12. Prepare the drawing therefore by the horizontal line, picture line, vanishing points 1 and 2, and measuring points 1 and 2 all as fig. 33.

It is proposed to place in Perspective a pointed arch of which the geometrical elevation is given at A, D, B.

Describe the oblong A, *a*, *b*, B about the arch, find the centre of the base *o*, and draw the lines *a*, *o* and *b*, *o*.—Draw line *c*, *d* through the intersection of *a*, *o* with the arch.—We have a rectangular figure enclosing the curved lines, and right lines intersecting the curve as in the last figure; we have only to place this rectangular plane A, *a*, B, *b* in Perspective with the lines *a*, *o*; *b*, *o* and *c*, *d* upon it in order to draw the arch; this is done at A′, *a*′, B′, *b*′, *o*′ D and *c*′, *d*′.

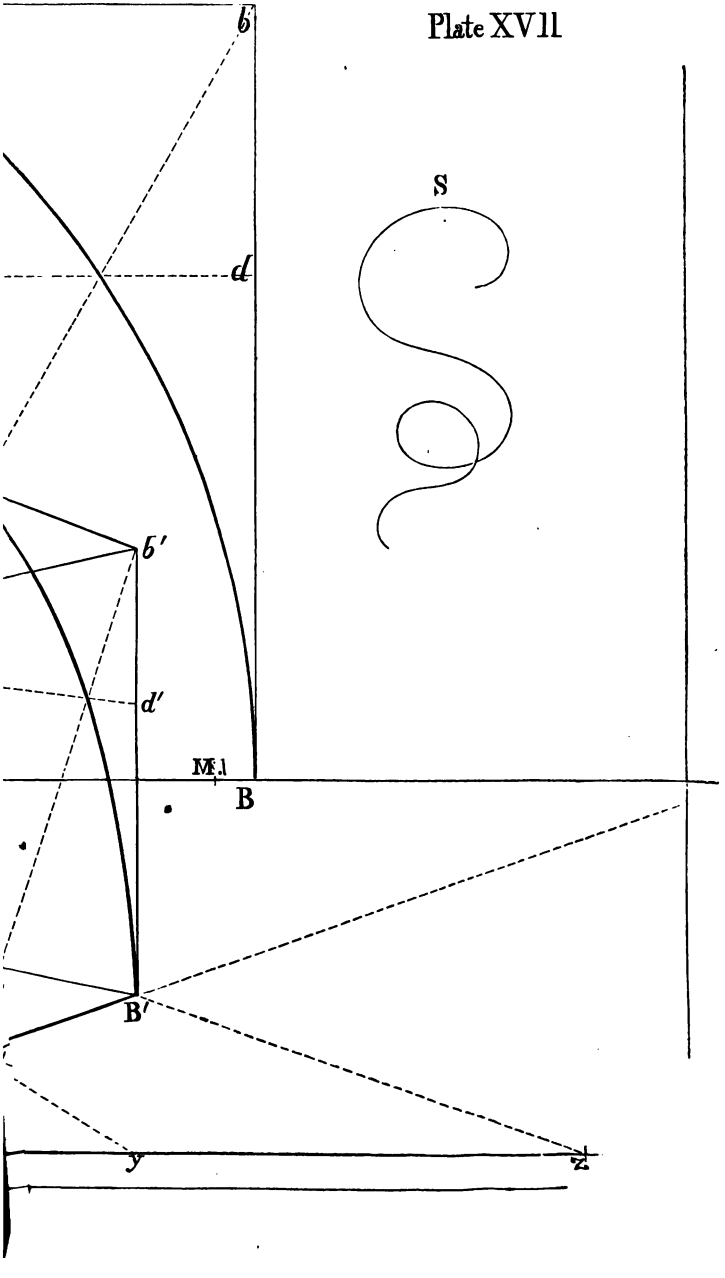
We now propose to construct the thickness of the arch which we assume to be 8 feet by scale, A′, A″ will be the thickness, at A″, we construct a plane, parallel, and equal to the plane A′, B′, *a*′, *b*′ as plane A″, B″, *a*″, *b*″.

The points *c*″, *o*″, *d*″ and *d*″ are transferred to the plane A″, B″, *a*″, *b*″ and the lines *a*″, *o*″; *b*″, *o*″ and *c*″, *d*″ are drawn and the curve passing through the points of intersection as before.

It cannot be necessary to give any detailed instruction for the drawing of this figure more than is furnished by the

lettered Plate; the student will understand that the thickness of arches, whether semicircular, elliptical, or many centred, can present no new difficulty, or require any different treatment; as many more points may be assumed as may be required, and by this means any curve, however irregular, may be correctly drawn, as line S.

Plate XVII



LESSON XV.

PLATE 18, FIG. 39.

WE propose still further to practise the placing arches in perspective.—On the ground line G, fig. 39, construct a square of 12 feet by scale. 4 inches, within its sides, at each angle, erect a pier 1 foot square and 10 feet in height, as at A, B, D, E.—Join the adjacent faces of each pier by semicircular arches having the same thickness as the piers, by the same process as employed in fig. 38.—Thus, we have *the half* of the semicircular arch described in plan at F, and, in perspective on the plane *a*, *b*, *c*, *d*—in order to obtain the centre of the arch draw the diagonals *a*, *d* and *b*, *c*; through the point of intersection draw a vertical line cutting *a*, *b* in *o*, and proceed as in the last figure: it is presumed that no instruction can be necessary to enable the student to place the geometric plane F within the picture, the working lines are however left.

The whole process is so precisely a repetition of that performed in the last figure, that any further description must be unnecessary.—The top of the pier A is joined to the top of the pier B, and the centres of the two semicircles forming the front arch obtained on its two joining lines as at *o*—the centres of the two opposite semicircles, forming the back arch, are obtained in a similar manner.

We will suppose, therefore, that the student has, without difficulty, completed the drawing of the four semicircular arches connecting the four piers A, B, D, E, and we now proceed to connect the piers A, E and B, D with each other by

means of arches or groinings—these arches or groins are to have the same height or *spring* as the semicircular arches, while, being on the diagonal of the square, their breadth or *span* will be greater than that of the semicircular arches; but this will not affect the lines of intersection by means of which we obtain the curve in perspective; therefore draw diagonals from *a* and *b* to the opposite angles—also from *c* and *d*, and we have two diagonal planes intersecting each other at their centres as at *o'*, draw lines from *o'* to their upper angles, intersecting a line drawn from *e* on line *a b*—that is, place upon these diagonal planes, lines similar to those on plane F, and draw the curve passing through the points of intersection.

Should, however, more points be desired through which to draw this curve, in perspective, the student must first make a geometrical drawing of the curve; in order to obtain this, proceed as follows, as at H. Draw line *a, g*, equal to line *o, c*, at F, that is equal to half the space between the piers; *a, g*, will be equal to half of the diagonal; bearing the same proportion to the whole diagonal plane on which the elliptical arch is required to be drawn, that the plane F does to the semicircular arch.

We construct the rectangular plane *a, g, h, i*, having a height equal to *a, c* at F.

In order to draw or *project* the curve required, we divide *o, a* at F into, say, four equal parts, and erect perpendiculars on the divisions to cut the curve. We divide the line *a, g* at H into the same number of equal parts (four) and erect perpendiculars. We now draw horizontal lines from the points where the perpendiculars at F cut the curve, and draw correspondent lines to cut the perpendiculars at H, the points of intersection give points through which to draw the curve required. If then more points of intersection are requisite on the perspective plane, the student may transfer the whole or any, of the horizontal and perpendicular lines he has just drawn, to the perspective plane:

The bases and capping of the piers the student may enrich

at his own discretion, the scale will tell him the dimensions and will give him all the assistance he can need.

The student who has carefully worked through the whole of the preceding course, may now take a retrospective view of the practice he has had and the knowledge he has acquired; he has been taught to place Planes in perspective having any desired relation to the ground and picture plane, to obtain any measurements upon those planes, and to place upon them any curved lines; and it is hoped that he is not only able to draw the figures given in the course correctly, but that he is also able to apply readily to other forms the same laws and methods of procedure. But the forms upon which the student has hitherto been exercised, may be regarded rather as rudimentary than as fully developed, their characters being plain and unadorned with those decorations and ornaments which commonly enrich structures, such as in practice are the subjects of the artist's labours. Thus the room at Plate 5; fig. 26 Plate 8; the chair at Plate 14; the subjects at Plates 15, 17, and 18, may be regarded rather as the skeletons than the completed forms of the objects they represent. In short, it has been sought to make him intimately acquainted with the *laws* of Perspective and with the results of those laws, rather than to impart to him mere methods of practice. With this object the system of obtaining all points and planes by means of vanishing and measuring points has been adopted, and their exemplification shown on subjects of a simple character; reserving until a later period any efforts to decorate or add *detail* to the objects represented, as well as the exhibition of other and different methods practically useful for drawing objects of a more strictly architectural character, these therefore, remain to be done; the student, however, must carefully bear in mind that the laws already expounded to him, will be the basis upon which all that remains to be done is performed, that he has no *new laws* to learn, and that what is to follow consists of methods of practice or *rules*.

LESSON XVI.

PLATE 19, FIG. 40.

WE propose to decorate the upper portion of one of the piers in fig. 39 with mouldings, or a capital and entablature. This capital and entablature are represented in profile, or *section*, on the plane *a*, *b*, *c*, *d*, fig. 40, Plate 19, and lines are drawn from the horizontal divisions to the edge *a*, *b* of this plane and from the vertical edges, some to the edge *a*, *c*, and some from the lower portion to the edge *b*, *d*.

We have then a rectangular plane *a*, *b*, *c*, *d*, with certain lines drawn upon it parallel to its edges, the *intersections* of which, give *points* from which the lines, whether straight or curved, which form the contour of the mouldings are drawn. It is merely a vertical plane with intersecting lines upon it. Therefore, as we can readily place this vertical plane in Perspective with all its intersecting lines, it follows that we may, without difficulty, obtain a perspective representation of the contour of the mouldings drawn on plane *a*, *b*, *c*, *d*.

The pier in fig. 39 was square, and we propose to continue the mouldings around its four sides, that is, we propose to *return* the mouldings.

The line *c*, *d* in the section represents the centre line of the pier, therefore the contour of the mouldings on plane *c*, *d*, *a*, *b*, represents the projection of those mouldings from the central line.

Let us then proceed to put the plane *a*, *b*, *c*, *d*, in Perspective as at *a'*; line *a'*, *b'* is equal to line *a*, *b*, and has the same divisions set off upon it, they are not numbered to avoid confusion in the Plate; from the divisions on *a'*. *b'*, lines are drawn to the centre

of vision C.* A horizontal line is drawn at a'; a', c', and a' z being each equal to a, c; the divisions on the line a, c, are transferred to the line a', c', as at $1'$, $2'$, $3'$, &c. &c., and lines are drawn from them to the distance point,† cutting the line from a' to C; from the points thus obtained, perpendiculars are dropped to intersect the lines drawn from the subdivisions on line a', b', to C, their points of intersection will be the representatives of the points of intersection on the geometrical plane, a, b, c, d, and the perspective contour of the mouldings can be drawn by the free-hand. The student is requested to observe that the entablature is first treated, numbering from a to 7 inclusive, the perpendiculars from those points being drawn to the top line a, c.

The piers in fig. 39 are square, and line c, d, fig. 40, is the central line of the pier, therefore a', c', which is equal to a, c, will represent one *half* of the width of the whole entablature, and line c', z the WHOLE width of the entablature, its upper member touching the plane of the picture; a line drawn from c' to the point of distance will therefore be one diagonal of the upper surface of the entablature, which we must remember is to be square; and a line from z to the other point of distance will represent the other diagonal. We have a line drawn from a' to C, and lines drawn from $1'$, $2'$, $3'$, &c., intersecting it; let us draw lines from those points of intersection to cut the diagonals from c' and z, and we shall obtain points from which to drop perpendiculars which will determine the perspective contour of the mouldings, by their intersection with horizontal lines drawn through the points of intersection obtained on the perspective plane a', b'; a reference to the Plate where all the lines are shown will, it is hoped, render any further explanation unnecessary. From c' and the angles of the mouldings below it, lines are drawn to C, which will be cut by perpendiculars from the points on the diagonal from z, and from the angles at z lines will be drawn, when visible, to C.

* The C to the right.

† The distance point is without the limits of the Plate.

The capital of the pier has been treated in a slightly different manner; it would have occasioned confusion to have drawn all the lines to the top lines *a*, *c*, and *a*, *z*, but no other reason prevents its being done; a line is therefore drawn at *e*, equivalent to 1 on *a*, *b*, as line *d'*, *e'*, and from this line a fresh commencement is made; lines being drawn from *e*, and the divisions on *e*, *b'*, to C, the distances on line *b*, *d*, in the section, as *b* 1, *b* 2, *b* 3, &c., &c., are set off from *e* on line *e*, *e'*, as at 1, 2, 3, &c., &c., and lines drawn from those points to the point of distance to intersect line *e*, C; from the points thus obtained perpendiculars are dropped, in fact, thus far the process is a repetition of that by which the entablature was obtained; but now in order to avoid the confusion which the attempting to draw lines from those minute subdivisions would occasion, we set off from *e* on line *e*, *e'*; *e* 1 equal to *d* 1, and draw a line from 1 to C, to cut the horizontal line drawn through the point of intersection of lines 1 D, and *e* C: that is, the top edge of the upper member of the capital: this will give us the outer angle of this member, and we can therefore draw a diagonal from this point to D. We might have obtained this point by setting off from *e* a distance equal to *d*, *b*, as at *e'*, a line drawn from *e'* to point of distance giving the same result: set off *d* 6, *d* 5, *d* 4, &c., &c., from *e* as at 6, 5, 4, &c., &c., and draw lines from those points to C, their intersections with the diagonals will give points from which to drop perpendiculars to terminate the mouldings of the capital. The other angles, those to the left, may be found by setting off upon the horizontal lines, from the central profile line, distances equal to those of the right side; the student will only require to draw the diagonal from the angle to the left, which will be cut by the lines 1, 2, 3, &c., &c., C, to determine the angles of the mouldings at the distant angles of the side to the right.

The student is requested to observe that, although thus a method somewhat different has been employed for the obtaining of the mouldings of the capital, from that used for the entablature, that variety has been suggested solely by convenience, and that either will apply in practice to both.

It remains to convert the square pier into a circular column, and its capital into that of a column as at fig. 41 ; the same section is employed as in fig. 40, but to prevent intricacy the scale is doubled, that is, the capital in fig. 41 is represented twice the size of that of fig. 40. Now the abacus, that member extending from 1 to 3 on the line *a b* in the section, is square, therefore it is obtained in the same manner as in fig. 40, and the contour of the capital at the central line is obtained in the same way as before ; through the points on the contour, also, horizontal lines are drawn, and the limits of square planes are obtained, as in the last case. Thus, planes 3, 5, 4, 5 and 6 are obtained precisely as the correspondent square planes in the capital of the pier ; it only remains to put a circle in Perspective upon each of these square planes equal to them in diameter. The half of the plane 3, and all the semicircles are shown in fig. 41, the working lines left on planes 3 and 6, and it is hoped no further explanation is needed.

The student will observe that the semicircles 4 and 5 are not vertically over the planes to which they belong, he must not, therefore, drop the lines by perpendiculars, but set off the points from the angles of the planes to which they belong.

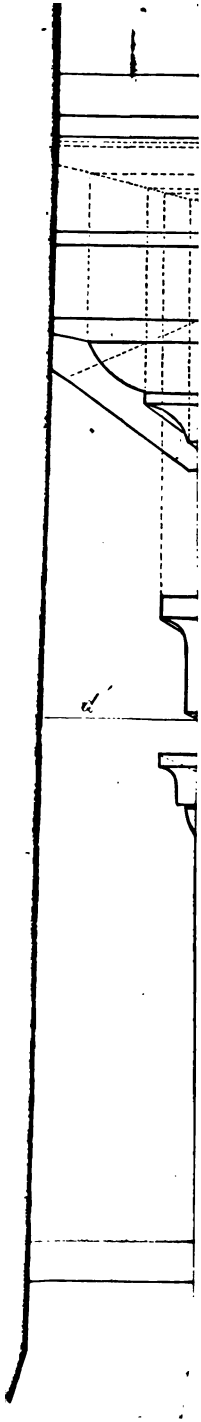
Although the product in the last two figures is moulded, fig. 40 is merely another application of the method employed to obtain the table in fig. 27, the upper surface of the entablature being employed as a plane on which the points are found from which to *drop* perpendiculars, precisely as in the table, the ground plane was employed on which to find points from which to *erect* perpendiculars, and the method by which the contour of the entablature is obtained, is merely a repetition of the process by which we obtained the rails of the table. The capital of the column has only required the addition of placing circles in Perspective on horizontal planes in order to complete it.

The centre of vision of fig. 40 is C to the right. That of fig. 41 C to the left, the points of distance are, in both cases, beyond the limits of the Plate.

LESSON XVII.

PLATE 20, FIG. 42.

IN fig. 22, Plate 5, we have the skeleton of an interior, in the present lesson, it is proposed to add detail to this figure. We have in fig. 42, Plate 20, a room 19 feet 4 inches wide, 12 feet deep, and 13 feet high. The student will require only the centre of vision and the point of distance for the window: the point of distance is, of course, without the limits of the Plate. On the side to the left, it is intended to construct a window 4 feet within the picture, with reveals of 1 foot (that is, the window will be set 1 foot within the wall). Line *a*, *c*, represents the edge of the side wall as in fig. 22. Upon this line a geometrical section of the window is drawn at *x*, *y*; *x* being 1 foot from *a* (the scale will show the dimensions of the section —which the student will observe are more adapted for clearness in point of size than for elegance). From every angle of the section, lines are drawn to C; let the student particularly observe those lying on the floor which are drawn from *x*, *z*. From *a*, 4 feet is set off on the ground line, and 7 feet 4 inches for the width of the window, as at 4 and 7, and lines drawn to cut the side wall as in fig. 22, and the opening of the window thus obtained. From *p*, the distant side of the window, a horizontal line is drawn to cut line *x* C, and from their points of intersection *v*, a vertical line is drawn, which joined, at its upper extremity, to the vertical line from *p*, gives the visible reveal of the window. Draw a line from point of distance through *v*, and produce it to cut the ground or picture line in *u* (see also at large at A); set off from *u* the depth of the bead *o*

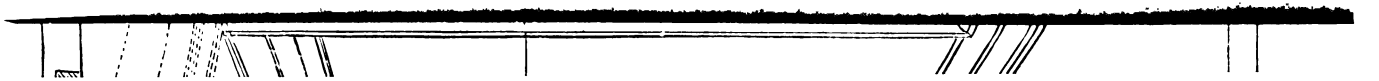

a'

as at *t*, and the depth of the stile, or side, of the sash as at *s*; and draw lines from those points to the point of distance to cut the lines from *x*, *z* to C, their points of intersection will give the plan of the sashes and frame in Perspective, and perpendiculars being erected from those points to cut the lines from the section *x*, *y*, will complete the window; its architrave or moulding surrounding the opening remains to be constructed. At *r*, on line *a*, *c*, a section of the architrave is represented upon the side of the wall; it is, in fact, the architrave brought up to the picture plane; from the angles of this section, lines are drawn to C. From the front of this section a line is drawn to cut the picture line in *q*, and from *q* a line drawn to C. At 4 and 7, sections *r*, *r* are also drawn on the picture line for the sides; from the vertical divisions of *r*, *r* on the picture line, lines are drawn to the point of distance to cut the side of the room, and from the points so obtained horizontal lines are drawn to cut line *q* C. This will perhaps be better understood from the enlarged section at B, where from *r* the lines are drawn to what may represent the picture line, as might have been done at *a*, *q*, and the divisions 1, 2, 3 set off as at 3′, 2′, 1′, lines being drawn from those points to point of distance, reference to the Plate will, it is hoped, render further description unnecessary.

On the opposite side of the room, it is proposed to open a door as in fig. 22; 8 feet from edge *b*, *d*; the door to be 6 feet wide; and to be open at an angle of 45° to the side of the room; for this, therefore, the opposite point of distance and its measuring point will be required, as the point of distance will be the vanishing point of the door. Find the opening of the door and complete its architrave as in the window, its architrave is represented at 7 and 8, on the picture line. Draw a line from D through the angle corresponding to *l*, fig. 22, that is line 8, D, and by its measuring point cut off upon it the width of the door; complete the plane of the door by its two vanishing points (the two points of distance); obtain the divisions or measurements, giving the upright framing or stiles of the door; for the horizontal framing or rails, draw a line from C through the

bottom angle of the face of the door and produce it to the picture line, set up a perpendicular from it for a line of heights, and set off upon it the geometrical divisions, carrying them back to cut the edge of the door.

The section of the cornice is given, and the process given in the last Plate for the entablature applying to this also, it cannot need repetition in the present lesson; the skirting falls under the same remark. The student must bear in mind that if the descriptions appear brief in the later figures, it is from the reason that he is supposed to have thoroughly understood the previous lessons; should he find any difficulty in working the drawings, he is strongly advised to go back to the more elementary figures on which the later ones are based.



LESSON XVIII.

PLATE 21, FIG. 43.

IN fig. 21, Plate 4, we have the skeleton of a room drawn in Perspective by means of a *plan* placed above the base line—lines being drawn from the different angles, &c., of this plan to the centre of vision, or place of the eye, which is therefore called its STATION POINT, those lines cutting the base line, as in 2, 5, 6, and 8; from those points perpendiculars are dropped, giving the *Perspective position* of the original points from which those lines were drawn to the station point: thus the perpendicular from 6, gives the line *l*, *m*, which is the angle of the room represented in plan at 4.

This method of placing objects in Perspective by means of a plan, may be applied to any subject, whether an interior or exterior; or to separate and detached objects—thus the room in Plate 5, more elaborately treated in the last plate, the table in Plate 9, or the capital in Plate 19, might any of them be treated in this way, as indeed might any other subject in the work. We propose, however to exemplify this as applied to an object, the sides of which make oblique angles with the plane of the picture.

In fig. 43, Plate 21, we have a vase, supported on a pedestal, the sides of the square pedestal making oblique angles with the plane of the picture, the vase being circular. Now it will be evident that we must first have the *geometrical facts*, the real dimensions of both vase and pedestal; both the measurements of the *plan* and of the *vertical* heights: these are shown at A, where a *section* of the *half* of the vase and pedestal is drawn.

Let us suppose the horizontal line, the line of direction, and the base line to be obtained, as in fig. 21, Plate 4. Upon this base line let us construct a plan of the vase and pedestal as at D. As we shall require circumscribing squares for the circular forms of the vase, we will make one angle of the square described about the largest portion of the vase touch the base line: the centre of this square being obtained will give a *point* in the plan corresponding to the *central line* of the section; they are therefore both marked 1; having drawn the *diameters* of the square we proceed to set off upon them the dimensions of the plan as shown by the section; making 1, 2, in the plan equal to 1, 2 in the section, and so on of all the dimensions, drawing squares for the plan of the base, and describing circles for the vase; at the same time describing squares about those circles: we will suppose then the plan to be prepared in conformity with those instructions.

We have now a *true section* and a *true plan* of the object, that is a section and plan which give us the facts of the object to be drawn in Perspective; and we may proceed from this point, as in fig. 21, to draw lines from the angles of the plan to the centre of vision, or station point, to cut the base line, and from the points so obtained, to drop perpendiculars: but let us first direct our attention to another step in the process. The section drawn at A it will be observed, is of no use beyond giving us the real dimensions, but the plan at D is employed for the Perspective drawing, by having lines drawn from its angles to the station point; its sides also give us the *vanishing points*, which we will suppose obtained by the student, as well as the position of the object in the picture; thus by dropping a perpendicular from the nearest angle of the plan (which touches the base line) we obtain the place of the circumscribing square of the circle forming the largest member of the vase, by drawing a line from the correspondent point in the section to cut this perpendicular: *this being the case because the square touches the plane of the picture at this point:* but we could not use, for a similar purpose, any other angle or point of the section, because

at no other point does the form touch the picture plane, and also because the section at A represents a view of one side of the object seen parallel to the plane of the picture; while we propose as seen in the plan to look at one of its angles. It will be seen, however, that we can construct an *imaginary section*, by means of the *plan* and the *true section*, from every angle of which a line may be drawn to its vanishing point; and the intersection of those lines with the perpendiculars from the base line will give us the form in perspective: this then we proceed to do.

Now let it be borne in mind that the object is to construct a section *that shall represent the recession of the object within the picture*, which the section at A does not do. We proceed then to produce the lines of one of the nearest sides of the plan to the base line as shown at *a*, *x*, *y*, *z*, and the intermediate lines *parallel* to those; treating thus every square in the plan of the pedestal and every circumscribing square of a circle in the plan of the vase. From the points *a*, *x*, *y*, *z*, and the intermediate points, drop perpendiculars, and intersect those perpendiculars by lines from the vertical divisions of the *true section* at A, and by this means construct an *imaginary* section as at E. (This section may appropriately be called imaginary because it *represents no fact*, but is merely a means to an end.) It will be seen at once that the imaginary section at E differs very considerably from the true section at A, that is, the different parts recede from each other more, making the whole much wider; this is caused by the angle which the form makes in the plan with the plane of the picture, for if the plan be supposed to be turned round until its sides became perpendicular and parallel to the picture plane, then the imaginary and the true section would be identical, if it were possible to obtain one; on the other hand did the side *a*, and the lines parallel to it, make a lesser angle with the base line, then the imaginary section at E would increase its difference from the real section.

We have dwelt thus upon this subject, as it is desirable that the student should understand *why* he proceeds in this way, and

that he should clearly recognise the difference between laws an methods, or rules, and also because he may find this method o frequent use.

Now then we proceed to draw from each angle of th imaginary section, lines to the vanishing point to the left cutting those lines by perpendiculars dropped from the point on the base line obtained by drawing lines from the angles o the plan to the station point—this will give us the visible sid *a*, *b* ; from the angles thus obtained draw lines to the opposit vanishing point to complete the figure. The circular forms ar obtained as in fig. 41, and they can therefore require no descrip tion here.

LESSON XIX.

PLATE 22, FIG. 44.

IN this plate we have another application of the method adopted in the last figure; A, being the section of a chair, and D, its ground-plan; the points lettered in the section corresponding to those similarly lettered in the plan.

The vanishing points are all *out* of the limits of the Plate, as is the station point for the plan; the *base line* being brought almost to coincide with the horizontal line: the centre of vision is shown.

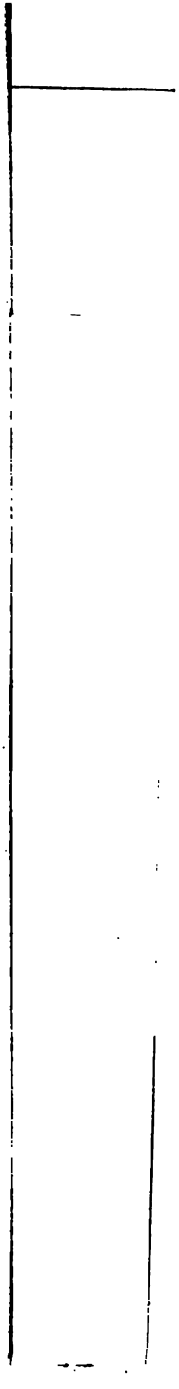
The coincidence of the station point and the centre of vision has hitherto been adopted only with a view to *exhibit at once the true relation of the parts* in the Perspective drawing, and not from any practical necessity—the use of the *station point* as such, is limited to the lines drawn to it, from the plan, intersecting the base line, and the obtainment of the vanishing points from that extremity of the principal visual ray at which the base line is drawn; and when this part of the process is completed, the nearness to, or distance between, the base line of the plan and the horizontal line may be left to convenience.

Any further explanation of this figure must be unnecessary, it being simply a repetition of the last, in method; we may mention, however, that the two sides of the chair will have different vanishing points.

With this subject then it is proposed to finish the course of perspective, it being considered unnecessary to multiply examples which would be repetitions of the same method, if the student study Perspective with a view to Architecture, any plan and elevation will supply him with a subject to which he may apply the knowledge he has already obtained: if for pictorial purposes any scene, article of furniture, or interior, will furnish him with

a theme; as has been previously mentioned the carefully and extensively practising each new step that he takes, by no means limiting himself to perhaps the single subject given in the book, but taking others and treating them in a similar manner, is the only way by which he may attain complete familiarity with the subject, the difficulty generally experienced in Perspective being in *its application* to subjects unfamiliar to the student. It is hoped that the endeavour here made to explain and render intelligible its *laws*, to base them upon simple optical truths, and to show that however varied the methods of practice, or great the number of *rules*, the laws and the facts upon which they are based are neither confounding from their nature or number, may not be altogether in vain; and it is believed with some degree of confidence, that the student who has steadily worked through the course will not tolerate a perspective drawing which declares itself to the eye as a falsehood, a fault too common in perspective representations; where squares not unfrequently are apparently converted into oblongs, *their short side to the spectator*, circles become elliptical, *with their greatest diameter perpendicular, and not parallel to, the spectator;* and where sometimes even the accommodating draughtsman represents what is *behind* as well as before him at one and the same time.

In the earlier portion of the studies, and indeed, but with few exceptions throughout, all the points have been shown in the Plates, and one uniform method has been adopted in reference to centre of vision, vanishing points and measuring points; in actual practice, however, expedients have frequently to be adopted to remove the difficulties arising from the great distance at which vanishing and measuring points lie, and the consequent great enlargement of the drawing; these, and a few other similar expedients which are often of great value when the student brings his knowledge into actual work, may appropriately be added, since it has seemed better to omit them whilst the course was systematically progressing, lest they should tend to produce confusion in the student's mind. To these then we proceed.



LESSON XX.

PLATE 23, FIG. 45.

—◆—

ON reference to fig. 25, Plate 7, it will be seen that it is there required to measure a certain distance into the picture in the case of line *c* C, and to measure a given length on the line *f* V. For the first the distance point is used, that is the distance point is the measuring point of the line *c* C: for the second a point is obtained which is the measuring point of all lines having their vanishing point in V. In both cases the *true* length of the line proposed to be cut off is set off upon the ground or picture line. This portion of fig. 25 is transferred to Plate 23, where we have, in fig. 45, the horizontal line, the picture line, points C, D, V and M, all set off precisely as in fig. 25, also line *c*, *d*, and line *f*, *g*; the product also in lines *c*, *m*, and *f*, *h*. Besides this, however, we have bisected the distance between C and D, and between V and M on the horizontal line, and have marked those points respectively ½ D and ½ M. We have bisected also the lines *c*, *d*, and *f*, *g*.

Now upon drawing lines from ½ *c*, *d*, to ½ D, and from ½ *f*, *g*, to ½ M, we shall find that the lines so drawn will intersect the lines *c*, C and *f* V in the same points as lines *d*, D and *g*, M. That is, by using *a half measuring point, and a half scale*, precisely the same end is attained as by using the ordinary measuring point and the whole scale; by this means then may some of the points necessary to be used in perspective be brought much more within the field of the picture, for this method may be adopted for *all measuring points*, bearing in mind the necessity of using the *half scale* at the same time.

Painters are often deterred from applying the rules of Perspective to their designs, from the great trouble which they experience in placing objects in a regularly prepared plan so as to approximately accord in result with their sketch; and finding, perhaps after many and repeated alterations, that the perspective resulting from the plan will not be "convenient," but will insist on putting the table or chair where they are not wanted, the painter abandons its aid altogether and trusts to his unaided perception of truth, a confidence not always justified by the result. He is the more tempted to do this, as frequently all that he needs from Perspective is, as it were, the *block of the object* without its detail.

We propose in fig. 46, to place the block of the chair represented in fig. 44, in perspective by another method, employing only the centre of vision and its measuring point, and without determining its distance within, merely assuming a point for its nearest angle as at X. We propose to use the half distance and the half scale: we therefore assume C, and obtain half the distance as at ½ D.

An outline of the plan is drawn at A (as mentioned before, we propose to use the plan and section of the chair in fig. 44), and a line B, drawn at its lowest angle, which we may call a base line; from this line perpendiculars are erected to every angle of the plan, they are numbered 1, 2, 3, 4, 5, and 6. This line B must always represent a line parallel to the plane of the picture, being indeed the representative of the ground or picture line; it must therefore be drawn in such relation to the sides of the chair in plan, as may appear likely to suit the requirements of the picture. We have now the plan of the chair, with its base line and the perpendiculars drawn from the base line to the angles of the plan. We have also a point X on which it is proposed the nearest angle of the chair should stand.

Draw a line from centre of vision, C, through X, to cut the picture line in 4′; and draw a horizontal line through X as B′, this may be termed a *moveable* or *floating base line*, it is a representative of line B placed within the picture on the ground plane.

From 4′, on the picture line, set off to the right and left the points 1, 2, 3, 5, and 6 on the base line B, as at 1′, 2′, 3′, 5′, and 6′, and draw lines from those points to C cutting line B′ in 1″, 2″, *x*, 4″, 5″, and 6″. Now those lines are of course the infinite perspective representatives of the perpendiculars 1, 2, 3, &c.; we have therefore only to cut off portions of those lines representing the *length* of the perpendiculars in order to find the seat of each angle of the chair. In order to do this we must obtain on line B′ the perspective representatives of the real length of the perpendiculars, or as we propose to use ½ D and ½ scale, the ½ of them; therefore we set off from 1′, half the length of the perpendicular 1, as at *a*, and drawing a line from *a* to C cutting line B′ in ½ 1, we obtain the perspective representative in line 1″, ½ 1 of the perpendicular 1 removed to the required distance within the picture. We now draw a line from ½ 1 to ½ D cutting line 1″, C in *y*. From 3′, we set off the half of perpendicular 3 as at *b*, carry it to line B′ as at ½ 3, and draw a line to ½ D cutting line 3 in *u*. From 6′ in the same way set off half 6 as at *c*, and in the same manner obtain *v*. We have only now to join points *v*, *u*, *y* and 4″ to obtain the plan of the chair in perspective.

Now at a very early stage in the process, it will be apparent whether the angles or lines of the sides of the chair are such as will suit the purpose; if they are not, it is only necessary to rub out the base line and the perpendiculars in the plan, re-adjust the base line and recommence.

We will, however, suppose the first plan *u*, *v*, 4″, *y* to be satisfactory, and proceed to the seat of the chair.

At 4′ erect a perpendicular equal to the height of the chair as at 4‴, and draw a horizontal line at its extremity; transfer to this line the points 1′, 2′, 4′, and 5′, as at 1‴, 2,‴ &c., and draw lines from those points to C. Erect perpendiculars from *x*, *y*, and *z*, *z*, to cut the lines last drawn to C. Join the points so obtained and the plan of the seat of the chair is obtained. By a repetition of the process, the lines of the back may be obtained and the *block* of the chair thus completed.

The chair is thus placed within the picture without the use of vanishing points, which would lie at a considerable distance without the limit of the plate, it is placed at once in the place in which it may be required, and should the angles made by it with the plane of the picture not be suitable, much less trouble is demanded to correct it, than would be requisite were the chair planned as in fig. 44, whilst at the same time the proportion and size of the object relative to its recession within the picture is accurately preserved.

It is often required in practice, to find the convergence of lines on a plane, the vanishing point of which may lie at an inconvenient distance; the following geometrical method of dividing a line proportionally to another given divided line, may therefore be useful should the student not be acquainted with geometry.

In fig. 47, Plate 24, we have two vertical planes, A B and A C. On the edge A of the plane A, B, are certain divisions, 1, 2, 3, 4, from which it is required to draw lines converging to the same vanishing point as the upper and lower edges of the plane.

Draw another line equal to line A, as *a*, and set off upon it the divisions 1, 2, 3, 4.

Draw a line equal to line B *parallel* to line *a*, and at any convenient distance from it, as line *b*.

Join the extremities of lines *a* and *b*, and produce the lines to cut, as in *d*. From 1, 2, 3, 4, on line *a*, draw lines to *d*. Such lines will proportionally divide line *b*. Set off those divisions on line B and draw lines from 1, 2, 3, 4 on line A to the correspondent divisions on line B; such lines will converge to the same vanishing point as the upper and lower edges of the plane.

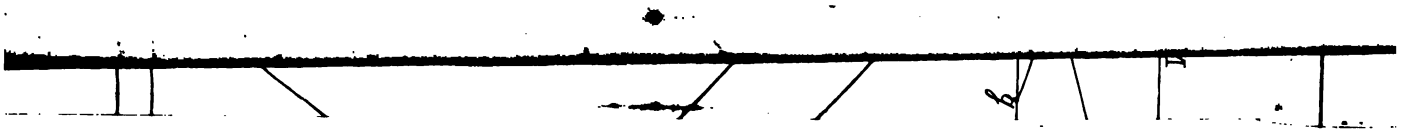


Plate XXIV.

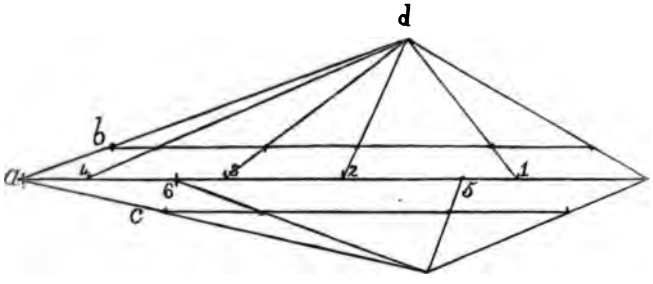
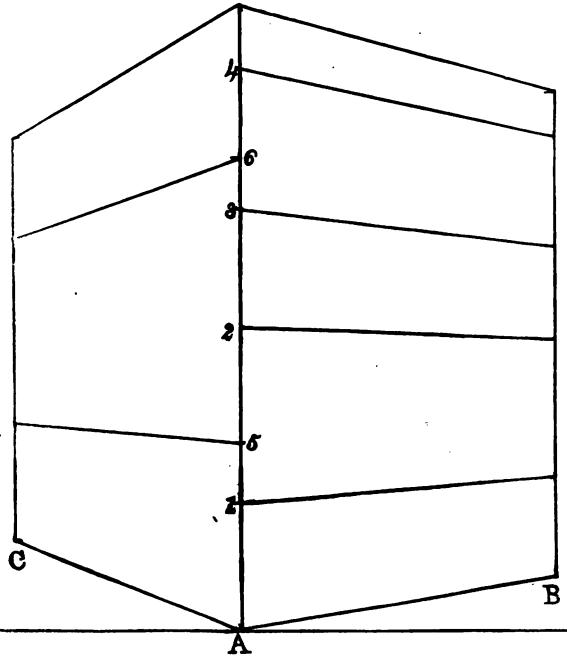


Fig. 47.



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THE END.

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